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Snapshot of coastal stream mouth water quality in the Coromandel area (January/February 2015)

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Executive Summary

There are many small stream mouths that flow to beaches in the Coromandel area. These stream mouths support a wide range of aquatic life and are often popular swimming locations, particularly with children. The water at these locations can be susceptible to contaminants washed from the catchment because the mixing of water with seawater is often limited. Furthermore, some of the stream mouths become blocked regularly as a result of natural coastal processes.

Waikato Regional Council sampled the water quality of 18 of these stream mouths in the Coromandel area during January and February 2015. The purpose of this investigation was to provide a one-off snapshot of coastal stream mouth water quality in the Coromandel area and to trial a new approach to investigate potential sources of faecal bacteria such as humans, possums, dogs, pigs, gulls, ruminant animals, and more specifically, cows.

The sampling programme was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a human health risk. It is important to note, however, that this report does not make specific comments on public health, such as whether a location is deemed safe to swim or not, as this is out of scope and outside of Regional Councils' jurisdiction.

Results were explored in the context of three environmental parameters that are known to influence coastal water quality: rainfall, river flows, tide height, and catchment land use. In doing so, this report describes patterns in water quality over the Coromandel area during the two months of sampling rather than providing a detailed interpretation of the results obtained at each individual location.

Parameters relating to the ecological health of a stream mouth were compared to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (also known as the ANZECC guidelines) for estuarine water quality in south-east Australia.

Exceeding an ecological health guideline value does not imply that there are necessarily any adverse environmental effects. Instead, multiple or large exceedances of these guidelines may trigger further investigations to be carried out to determine the cause of the exceedance and if there is a problem.

Results from the study showed that turbidity was typically low at all sites across the region, indicating that water clarity in the stream mouths was good.

Most sites had dissolved oxygen concentrations within the ANZECC guideline value most of the time.

The study also revealed that nutrient concentrations (nitrogen and phosphorus) were within ANZECC guideline values 59% of the time across all sites. The most common ecological health parameters to exceed guideline values were ammoniacal nitrogen and nitrate and nitrite nitrogen. The samples from some sites, such as Whangarahi and Wigmore Streams, consistently exceeded these nutrient guideline values, whereas samples from Manaia River and Te Mata Stream, for example, were consistently within nutrient guideline values. These exceedances do not necessarily point to significant environmental problems; however, further investigations should be carried out to determine whether these are persistent patterns and what may be causing them.

The recommended parameter for determining the suitability of coastal water for contact recreation in the marine environment is enterococci, a genus of bacteria that typically originates from the intestines of warm blooded mammals. Enterococci results were compared to the Ministry for the Environment Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas. An exceedance of the recommended guideline indicates an elevated potential health risk.

The median enterococci concentration over the eight sampling weeks was within the recreational water quality guideline value at 13 out of the 18 sites.

The highest enterococci concentrations were detected during sampling weeks three, five, and seven across the region. These coincided with spring tides or heavy rainfall events, which probably washed contaminants from the land into nearby waterways. Microbial source tracking was conducted on samples with elevated enterococci concentrations from these occurrences.

Microbial source tracking identified one of the main sources of faecal bacteria to be ruminant animals. Additionally, possum and gull sources were identified at most locations most of the time. Human sources were detected at few sites but only on some occasions. Due to the nature of the microbial source tracking technique, direct comparisons could not be made between the different markers to determine the relative contributions from each source.

This study has shown that the water quality in stream mouths can be extremely variable. The low flow and frequent blockages of the stream mouth can make these locations particularly susceptible to contaminants washed from the land, most notably during spring tides and following heavy rainfall. This highlights the importance understanding the environmental processes that may lead to compromised water quality in stream mouths so that we can better inform communities.

The trial of microbial source tracking provided some useful information on the potential sources of faecal contamination at the study locations. The methodology used in this study, however, is not yet at the stage where Waikato Regional Council can use it to make reliable statements on the causes of coastal water quality degradation.

1 Introduction

The Coromandel Peninsula is valued for its social, economic, and cultural contribution to the Waikato region. The numerous beaches in the area and the small streams that flow into them play a large role in these values. These small coastal stream mouths support a wide range of aquatic life and are popular swimming locations, particularly with children. These streams can drain large catchments and are therefore influenced by many upstream activities and land uses. It is important that we understand the quality of the water that is flowing out of these streams into popular beaches so we can gain information on their ecological health, that is, their ability to support and sustain aquatic life, and determine their suitability for recreational use.

The majority of stream investigations in the Coromandel conducted by Waikato Regional Council have occurred upstream, with very few investigating the water quality at the stream mouth. These stream mouths contain a mix of salt and fresh water, are typically low flow environments, and are often poorly flushed. This can make them particularly susceptible to degraded water quality.

To address this information gap, Waikato Regional Council conducted a one-off survey into water quality at coastal stream mouths around the Coromandel area during January and February 2015. Water samples were collected weekly from a range of stream, river, and creek mouths; for simplicity, they will all be referred to as coastal stream mouths or stream mouths in this report.

The purpose of this investigation was to provide a one-off snapshot of coastal stream mouth water quality in the Coromandel area and to trial a new approach to investigate potential sources of faecal bacteria. In doing so, this report describes patterns in water quality over the Coromandel area rather than providing a detailed interpretation of the results obtained at each individual location.

The sampling programme was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration of faecal bacteria that, at high levels, can indicate a health risk. The latter, when assessed against the appropriate guideline, is often referred to as the suitability for contact recreation (e.g. swimming and surfing). It is important to note, however, that this report will not make specific comments on public health, such as whether a location is deemed safe to swim or not, as this is out of scope and outside of Regional Councils' jurisdiction.

There can be many sources of faecal bacteria in the coastal marine area. Detecting bacteria in a water sample, however, does not indicate its source. One technique for identifying potential sources of these bacteria is microbial source tracking. This technique identifies genetic markers from host specific faecal bacteria in the water sample that can be traced back to a specific source, e.g., cows, humans, possums, dogs, pigs, and gulls. This technique has not been used before in the Waikato region's coastal marine area and this study was suitable to test such a technique.

Results were explored in the context of three environmental parameters that are known to influence coastal water quality: rainfall, river flows, and tide height. This survey was not designed to provide robust or authoritative statements on the causes of coastal water quality degradation at the sampling locations; instead, it describes patterns in water quality over the Coromandel area during the two months of sampling in the context of environmental parameters.

2 Methods

2.1 Locations

Site locations were determined by considering their popularity for recreation and whether members of the community had previously raised concerns with Waikato Regional Council regarding water quality.

Eighteen coastal sites were selected (Table 1; Figure 1).

Table 1: Names and coordinates (NZTM) of the 18 water quality sites sampled weekly during January and February, 2015.

Site name	Nearest locality	Easting	Northing
Whangarahi Stream	Coromandel Town	1822517	5929048
Manaia River	Manaia	1820551	5918744
Te Mata Stream	Te Mata	1822457	5905586
Te Puru Stream	Te Puru	1824074	5897435
Pitoone Stream	Pitoone	1841648	5931912
Kuaotunu River	Kuaotunu	1843793	5932506
Otama Stream	Otama Beach	1846918	5934042
Stewart Stream	Opito Bay	1850157	5932477
Tohetea Stream	Simpsons Beach	1842931	5923553
Tarapatiki Stream	Whitianga	1840901	5923246
Taputapuatea Stream	Whitianga	1840806	5921813
Purangi River	Cooks Beach	1846063	5919649
Wigmore Stream	Hahei	1850709	5918814
Taiwawe Stream	Hot Water Beach	1851544	5913836
Grahams Creek	Tairua	1854322	5901719
Pepe Stream	Tairua	1853453	5900941
Otahu River	Whangamata	1855410	5875683
Te Ramarama Stream	Whiritoa	1857035	5870355

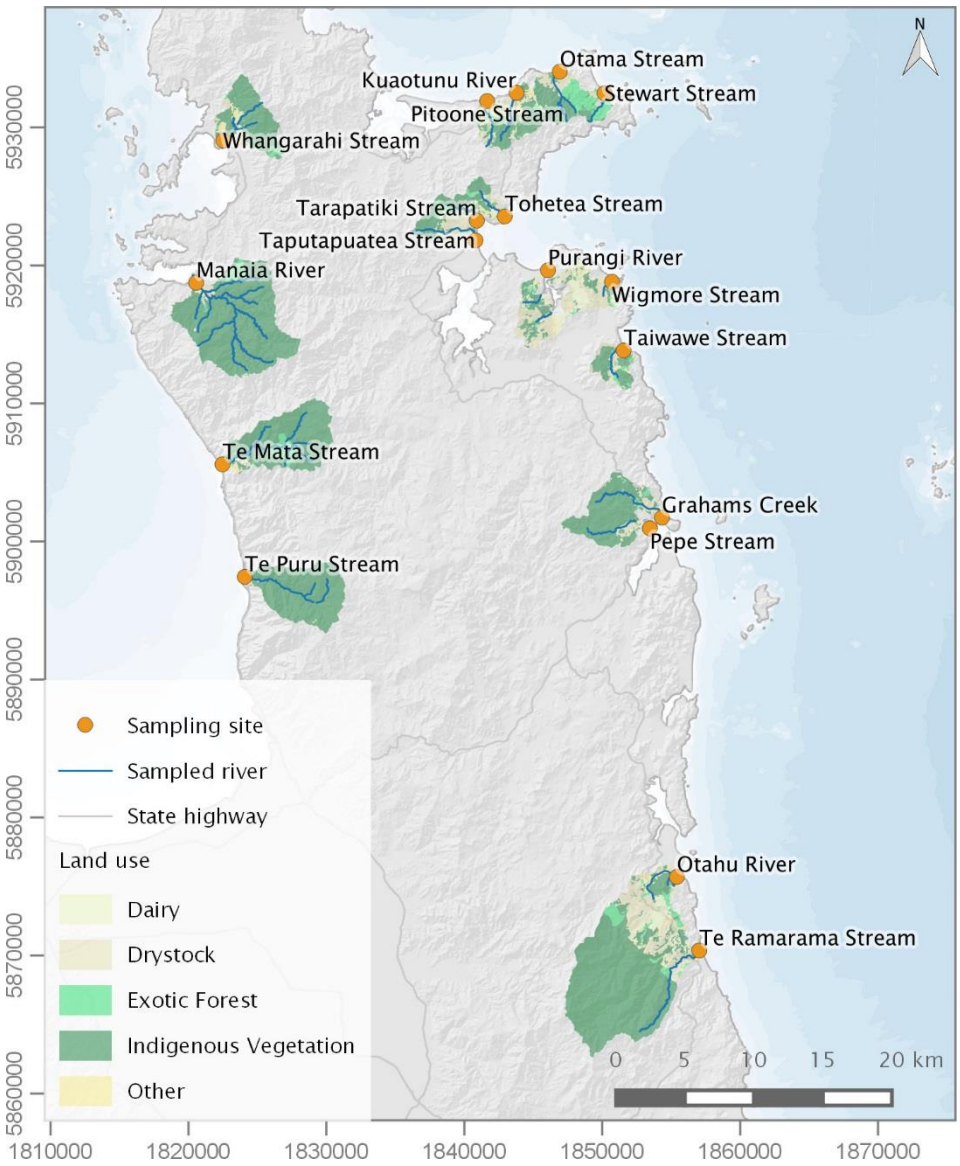

Figure 1: **Locations of the 18 water quality sample sites in the Coromandel area that were surveyed weekly in January and February, 2015. The size and land use of each stream's catchment is indicated by the coloured shading. NZTM coordinates are indicated on the surrounding frame.**

2.2 Sample collection

Waikato Regional Council conducted weekly sampling at each stream mouth from 7 January to 23 February 2015. Samples were collected over this period to get a snapshot of coastal stream mouth water quality during a time with high recreational use from locals as well as visitors to the area.

Samples were collected during the outgoing tide and at least 30 minutes after high tide (

Table This was to ensure that contaminants from the catchment could be investigated in the coastal stream mouths, rather than just the effect of dilution from oceanic water.

Collected samples were stored on ice and transported to Hill Laboratories (Hamilton) for analysis within 24 hours.

2.3 Water quality parameters

Each water sample was analysed in the laboratory (Hill Laboratories) for a range of parameters including aspects of water clarity (turbidity and suspended solids) and nutrient concentrations (nitrate + nitrite nitrogen, ammoniacal nitrogen (ammoniacal nitrogen), total nitrogen, and dissolved reactive phosphorus) as indicators of ecological health, and *Escherichia coli* (*E. coli*), enterococci, and faecal coliform counts as indicators of pathogens, and therefore, suitability for recreational use (e.g., swimming). In addition, water temperature and dissolved oxygen concentration were measured on-site at the time of collection with a handheld optical dissolved oxygen probe. Further details on parameter detection limits and analysis methods are presented in Appendix A.

Dissolved oxygen concentration was not measured on two sampling occasions at Whangarahi Stream, Manaia River, Te Mata Stream, and Te Puru Stream and one occasion at Purangi River, Wigmore Stream, Taiwawe Stream, Grahams Creek, Pepe Stream, Otahu River, and Te Ramarama Stream due to instrument faults.

The relevance of measuring a parameter and the guideline (threshold) value that it is measured against are presented in Table 2.

The guideline values relating to ecological health are from the Australian and New Zealand Guidelines for Fresh and Marine Water Quality by the Australian and New Zealand Environment and Conservation Council 2000, herein referred to as the 'ANZECC guidelines'. There were no New Zealand specific guidelines for estuarine water quality at the time of writing this report. The ANZECC guidelines recommend that values for south-east Australia be used in the absence of more appropriate regional or national guideline values in New Zealand.

The ANZECC guidelines provide very conservative guideline values and exceeding one of these values does not imply that there are any adverse ecological effects; instead, it indicates that further investigation should occur to determine the cause of the exceedance and to determine whether there are any adverse ecological effects.

Guideline values for parameters relating to contact recreation are from the Microbiological Water Quality Guidelines for Marine and Freshwater Recreational Areas 2003 by the Ministry for the Environment and Ministry of Health; herein referred to as the 'recreational water quality guidelines'.

Table 2: Water quality parameters, their relevance, and the guideline value used to assess the current environmental state. Guideline values for ecological health and contact recreation parameters were obtained from the ANZECC guidelines and recreational water quality guidelines, respectively.

Water quality variable	Relevance	Guideline value	Unit
Ecological health			
Dissolved oxygen saturation	Oxygen for aquatic animals to breathe	Upper limit: 110 Lower limit: 80	%
Turbidity	Can restrict plant growth	10	NTU
Total nitrogen	Can cause nuisance plant growth	0.3	g/m^3
Nitrate-N + nitrite-N	Can cause nuisance plant growth	0.015	g/m^3
Total ammoniacal-N	Can cause nuisance plant growth	0.015	g/m^3

Dissolved reactive phosphorus (DRP)	Can cause nuisance plant growth	0.005	g/m^3
Contact recreation			
Enterococci (single sample)	Human health	280	cfu/100 mL

2.3.1 Microbial source tracking

To investigate potential sources of bacteria in the water, Waikato Regional Council contracted Cawthron Institute to use a microbial source tracking technique. This technique identifies genetic markers in the water sample that can be traced back to a specific animal or human source. The details of this method are described in Appendix B.

Hill Laboratories filtered each water sample and froze the filter at −80°C. Microbial source tracking was conducted on pre-filtered and frozen samples from weeks three, five, and seven, which were identified to have highest bacterial concentrations across the region. Selected samples were analysed for the following genetic markers:

- ruminant animals,
- cows,
- humans,
- possums,
- gulls,
- dogs, and
- pigs.

Due to the nature of the microbial source tracking technique, it is not possible to directly compare the results (abundance) of one marker with another; they are all on different relative scales. Some cross-reactivity can also occur, where contamination from an organism that the marker is not targeting results in a false-positive (e.g. the ruminant Bacteroides marker has been shown to cross-react with faecal material from brushtail possums).

2.4 Data analysis

Raw data were imported into the software R (version 3.2.2) for all statistical analyses.

Values below the detection limit of the analytical method were deemed to be half of the detection limit to conduct statistical analyses (e.g., <0.05 g/m^3 = 0.025 g/m^3).

Statistical investigations were conducted on rainfall, river flow, and tide height to identify potential influences on stream mouth water quality, specifically the concentration of enterococci.

Daily rainfall measurements were obtained from two monitoring stations, The Pinnacles, (easting 1840723, northing 5897068; NZTM) and Castle Rock (easting 1827932, northing 5925751; NZTM). Daily rainfall was calculated as the sum of rainfall between midday on the day the water sample was collected and the midday on the previous day.

River flows were measured at two Waikato Regional Council monitoring sites: Tapu River (1822967, 5904237; NZTM) and Tairua River (1843320, 5890290; NZTM).

Tide heights for Thames were measured at the Waikato Regional Council tide gauge (1823936, 5888032; NZTM) and the tide heights for Whitianga entrance were calculated by the NIWA tide forecaster[1]. The tide forecaster was used instead of the Waikato Regional Council tide gauge within the harbour as a more representative indication of open coast tidal patterns. The maximum tide height in Whitianga on the sampling day was used in statistical calculations for simplicity.

[1] https://www.niwa.co.nz/services/online-services/tide-forecaster

Where appropriate, variables were correlated to enterococci concentrations using linear models. Analysis of covariance (ANCOVA) was used to determine the environmental parameters that best explained the variation in enterococci concentration. The optimal number of parameters and interactions between parameters for the ANCOVA model was determined by a stepwise algorithm (R 'step' function).

3 Results

Parameters with guideline values listed in Table 2 are presented in the relevant sections below. As previously mentioned, an exceedance of an ANZECC guideline value does not imply any adverse environmental effects, but may trigger further investigation to determine the cause and effect of the exceedance. Results of all water quality analyses, including those without guidelines for comparison against, are presented in Appendix C.

3.1 Ecological health

The following parameters are indicative of the ecological health of the stream mouth based on water quality measurements (Figure 2; Table 3). At most sites, ecological health was good the majority of the time. At some locations, specific ecological health parameters exceeded the ANZECC guideline values on occasion. These are described in further detail in the remainder of this section. These results are also presented in full in Appendix C and on maps in Appendix D.

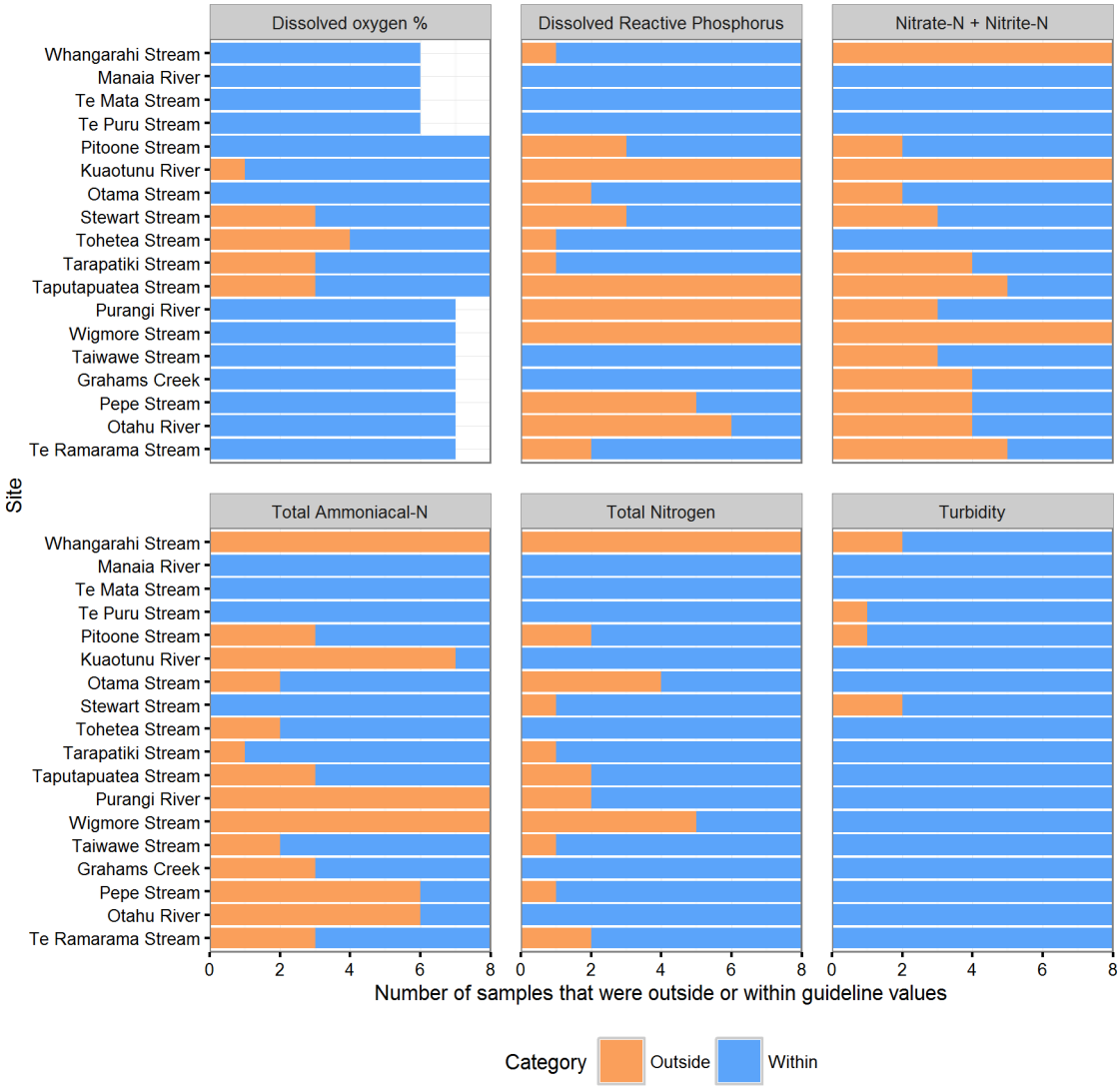

Figure 2: Number of water quality results that were outside or within ANZECC guidelines for the samples collected weekly from 18 Coromandel streams for eight weeks during January and February 2015.

Dissolved oxygen saturation and turbidity were within the ANZECC guideline values most of the time at most sites. This indicates that the water at the stream mouths was usually well oxygenated and had high visual clarity at the time of sampling.

Following on from the turbidity of the water, the concentration of suspended sediment was also relatively low at most sites. There was a slight peak (>50 g/m^3) in the suspended sediment concentrations measured in late February at Whangarahi and Te Puru Streams.

The water temperature at all sites was relatively high, with a median temperature >21 °C. The range of measured temperatures was also large, with up to a 5 °C difference between sites per sampling occasion. These relatively high temperatures likely occurred due to a combination of the low flow nature, and occasion blocking of the stream mouth, of these types of water along with higher temperatures over summer. These elevated temperatures may have been a stressor to aquatic life.

Nutrient concentrations (nitrogen and phosphorus) varied markedly among sites. For example, the nutrient concentrations at some sites were always within ANZECC guideline values, notably Manaia River and Te Mata and Te Puru Streams, whereas the nutrient concentrations at other sites were over 100 times the guideline value on occasion.

Samples from Whangarahi Stream were within the guideline for dissolved reactive phosphorus on all but one sampling occasion. On the other hand, all nitrogen parameters consistently exceeded their respective guideline values. On occasion, nitrogen concentrations exceeded guideline values by 100 times.

At Kuaotunu River, the dissolved reactive phosphorus concentration consistently exceeded the guideline, with a median concentration that was three times greater than the guideline value. Similarly, nitrate/nitrite concentrations always exceeded the guideline, but the median concentration was only about one and half times the guideline value. Ammoniacal nitrogen concentrations exceeded the guideline on seven out of eight sampling occasions and the median concentration was four times greater than the guideline value.

Samples from Taputapuatea Stream exceeded the nitrate/nitrite guideline value on five out of eight sampling occasions. Ammoniacal nitrogen and total nitrogen concentrations were within guideline values more frequently, only exceeding their respective guidelines on three and two sampling occasions, respectively.

The total nitrogen concentration at Purangi River was within the guideline value on six out of eight sampling occasions. Contrastingly, dissolved reactive phosphorus consistently exceeded guideline values, and its median concentration was twice the guideline value. The median ammoniacal nitrogen concentration was particularly high at 15 times the guideline value and exceeded the guideline value in every sample.

Samples from Wigmore Stream consistently exceeded guidelines for all nutrient parameters (nitrogen and phosphorus). The median concentration of dissolved reactive phosphorus and ammoniacal nitrogen were particularly high, having values that were 15 and 10 times higher than the guideline, respectively.

Pepe Stream and Otahu River had similar median nitrate/nitrite, ammoniacal nitrogen, and dissolved reactive phosphorus concentrations, which exceeded guidelines on about half the sampling occasions. The median ammoniacal nitrogen concentration at each site was about 13 times greater than the guideline value and the median nitrate concentration was about four times greater than the guideline values. The median total nitrogen concentration was within the guideline value at both sites.

Table 3: **Median ecological health parameter results for each stream mouth and the overall median of the sites. Where applicable, ANZECC guideline values are presented in the last two rows. Median values that exceeded the guideline are highlighted in red.**

Site	Dissolved oxygen (%)	Dissolved reactive phosphorus (g/m^3)	Ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Turbidity (NTU)	Total suspended sediment (g/m^3)	Temperature (°C)
Whangarahi Stream	125.8	0.002	0.805	0.225	1.235	7.4	20.5	24.3
Manaia River	105.8	0.002	0.005	0.001	0.070	1.4	1.5	22.8
Te Mata Stream	106.8	0.002	0.005	0.007	0.110	0.9	1.5	23.1
Te Puru Stream	103.7	0.002	0.005	0.001	0.075	0.9	1.5	21.7
Pitoone Stream	92.5	0.005	0.005	0.012	0.215	4.1	6.5	23.0
Kuaotunu River	90.5	0.015	0.060	0.021	0.175	2.8	5.5	21.4
Otama Stream	98.7	0.002	0.005	0.010	0.320	2.1	4.0	22.1
Stewart Stream	87.3	0.003	0.005	0.010	0.190	4.2	5.0	24.0
Tohetea Stream	80.5	0.004	0.005	0.004	0.190	3.5	3.5	21.9
Tarapatiki Stream	87.8	0.002	0.011	0.015	0.180	3.7	6.5	23.1
Taputapuatea Stream	81.9	0.018	0.014	0.023	0.200	2.2	5.0	23.2
Purangi River	101.9	0.010	0.225	0.010	0.160	3.8	10.5	23.9
Wigmore Stream	106.1	0.077	0.155	0.075	0.420	2.2	8.0	23.4
Taiwawe Stream	109.1	0.002	0.005	0.010	0.225	2.9	4.5	24.2
Grahams Creek	106.8	0.002	0.013	0.055	0.145	2.4	7.0	22.3
Pepe Stream	108.7	0.006	0.205	0.055	0.225	2.2	7.0	21.6
Otahu River	106.5	0.006	0.220	0.055	0.190	1.0	3.5	21.8
Te Ramarama Stream	105.0	0.002	0.010	0.039	0.215	1.9	5.0	22.5
Median value	101.3	0.003	0.011	0.010	0.185	2.4	5.0	22.7
Range	34.9–212.8	0.002–0.760	0.005–2.100	0.001–0.640	0.03–2.60	0.4–73.0	1.5–127.0	18.7–29.6
Upper guideline	110	0.005	0.015	0.015	0.300	10	—	—
Lower guideline	80	—	—	—	—	—	—	—

3.2 Faecal indicators

Three different faecal bacteria indicators, enterococci, *E. coli*, and faecal coliforms were measured in each water sample. Enterococci is the preferred indicator in the marine environment for informing the suitability of contact recreation (MfE/MoH, 2003), therefore, all analyses were performed using this parameter. A summary of the results is presented in Figure 3. The complete results, including *E. coli* and faecal coliform measurements, are presented in Appendix C.

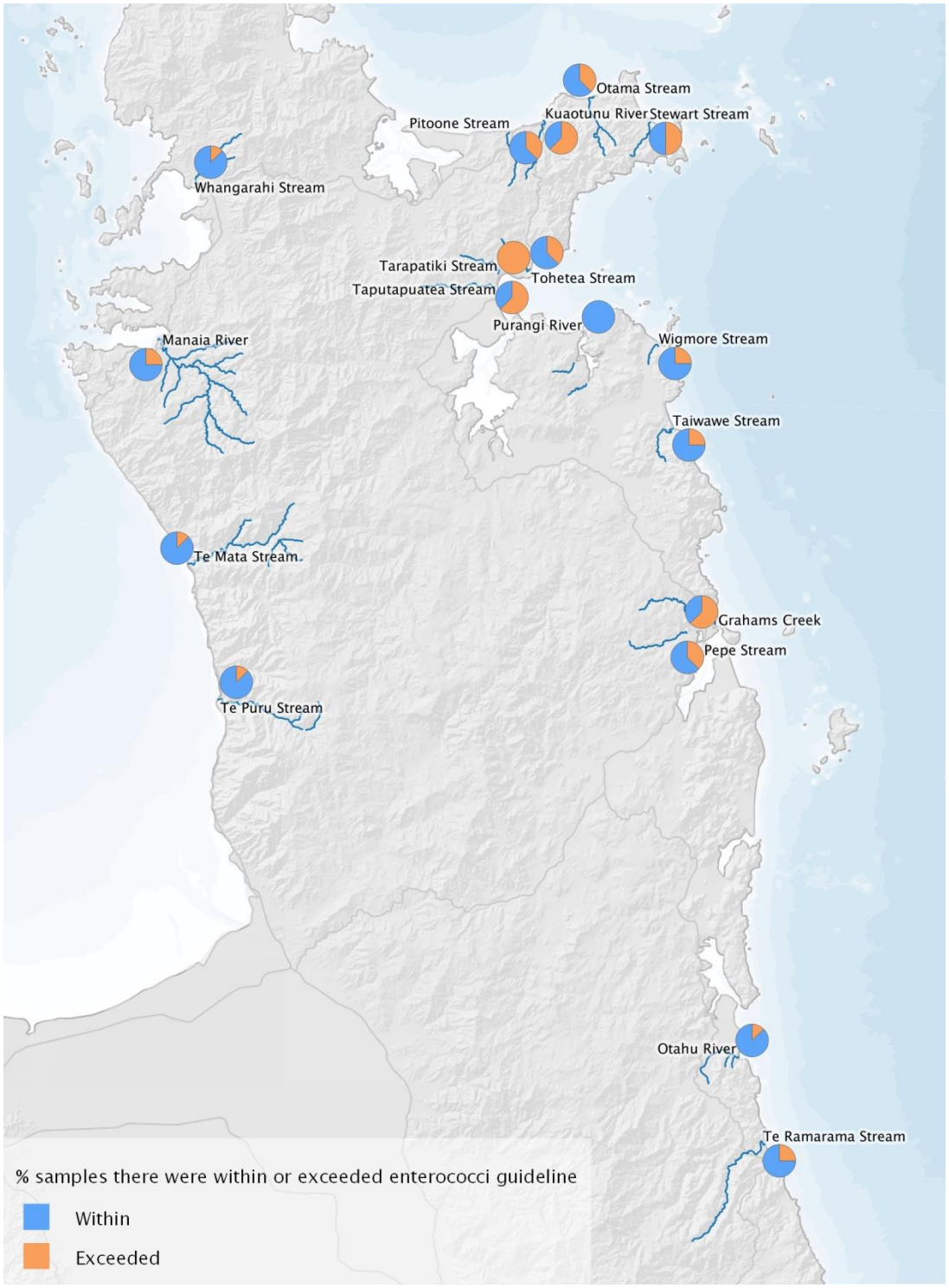

Figure 3: Percent of water samples from each stream mouth that were within or exceeded the recreational water quality guideline for contact recreation in coastal water of 280 cfu/100 mL. Samples were collected weekly during January and February 2015 (*n* = 8).

The median enterococci concentration over the eight sampling weeks was below the recreational water quality guideline value of 280 cfu/100 mL at 13 out of the 18 sites (Figure 4).

Sites with a median enterococci concentration above the guideline value were: Kuaotunu River, Stewart Stream, Tarapatiki Stream, Taputapuatea Stream, and Grahams Creek.

Purangi River was the only site to have all enterococci measurements within the recreational water quality guideline value. Contrastingly, the enterococci concentrations at Tarapatiki Stream exceeded the recreational water quality guideline value 100% of the time. This site also had the highest median enterococci concentration of 1250 cfu/100 mL.

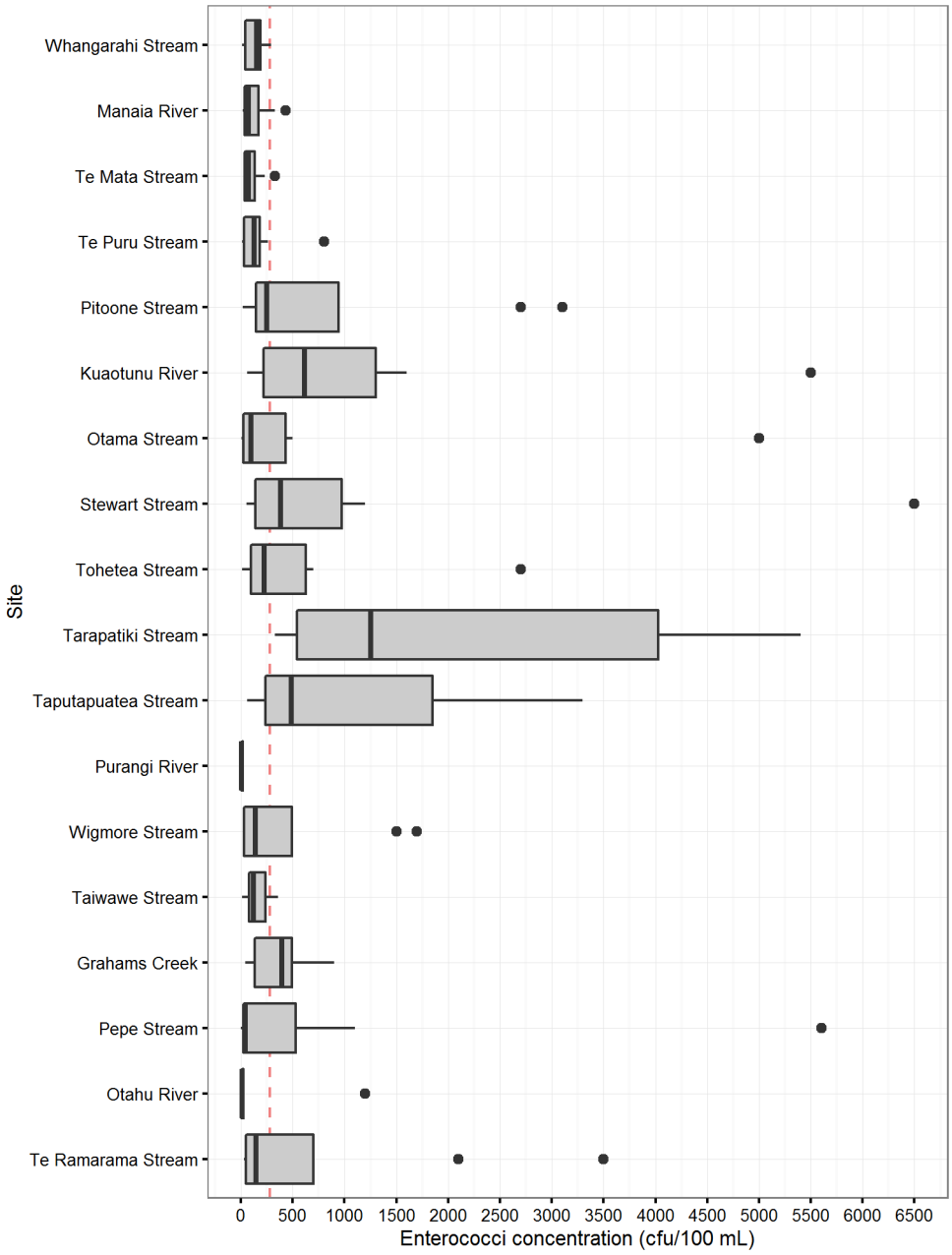

Figure 4: **Summary of enterococci concentrations measured weekly at each site during January and February 2015. The recreational water guideline value of 280 cfu/100 mL is indicated by the red dashed line. The extent of the grey box indicates the lower and upper quartiles of the measurements and the median is indicated by the heavier black vertical line. The range of the measurements is indicated by the horizontal black lines. Outliers were defined as more than 1.5 times the value of the interquartile range and are indicated by black circles.**

The summary presented in Figure 4 reveals that the sites can be grouped into three general groups based on their location: 1) west Coromandel from Whanagrahi Stream to Te Puru Stream, 2) north-east Coromandel from Pitoone Stream to Taputapuatea Stream, and 3) east Coromandel from Purangi River to Te Ramarama Stream.

The median enterococci concentration at each of the west coast sites was low and the range of measured enterococci concentrations was small. There were few exceedances of the recreational water quality guideline value (280 cfu/100 mL) at these sites.

Sites in the north-east Coromandel typically had the highest median enterococci concentrations and had the largest range of measured enterococci concentrations. The highest concentration measured during this period (6500 cfu/100 mL) was measured in this group at Stewart Stream, which is 23 times greater than the recreational water quality value. Such high concentration was only measured once at Stewart Stream, with the remaining enterococci concentrations being <1200 cfu/100 mL.

East Coromandel sites generally had enterococci concentrations that were greater than those of sites in the west but less than sites in the north-east. The median enterococci concentration at all sites, except Grahams Creek, was below the recreational water quality guideline value. Some sites, such as Pepe Stream and Te Ramarama Stream, had a high enterococci concentration on one or two sampling occasions, but typically, the concentrations were relatively low.

3.2.1 Microbial source tracking

There can be many reasons why enterococci concentrations are elevated in estuarine and coastal waters. Detecting elevated concentrations of enterococci cannot, however, provide any information on the potential sources of such elevation. To identify potential sources of faecal bacteria in the stream mouths, Waikato Regional Council used a microbial source tracking technique (Table 4).

The most commonly detected source of faecal contamination was from ruminant animals. Otahu and Purangi River were the only locations where the ruminant marker was absent. In addition to ruminant bacteria, possum and gull sources were identified at most locations most of the time. Due to the nature of the technique, however, it is not possible to determine the proportional contribution from each of the detected sources.

No samples tested positive for faecal markers from dogs at any of the sites. This means that dogs were not contributing to faecal contamination at detectible levels any sites during the two months of this survey.

Bacteria originating from humans were identified at a few sites some of the time. It is important to reiterate that it is not possible to accurately determine the total contribution of human bacterial sources in relation to other sources, such as ruminant animals. Sites with the highest levels of human-derived bacteria were defined in this study by having at least one result within the top 25% of all human-derived bacteria results across all sites. These sites were: Pitoone Stream, Kuaotunu River, Otama Stream, Stewart Stream, Tarapatiki Stream, and Grahams Creek.

Table 4: **Enterococci concentration and detected microbial source markers from water samples collected in weeks three, five, and seven of the summer sampling. Samples were analysed for ruminant, cow, human, possum, gull, dog, and pig microbial source markers. Samples that were not sent for microbial source analyses are denoted by a dash. Results in the top 25th percentile for each of ruminant, cow, and human microbial sources are presented in bold. Full details of the results are presented in Appendix C.**

Site	Week	Enterococci (cfu/100 mL)	Faecal sources detected
Whangarahi Stream	3	9	—
	5	290	Ruminant, human, possum, gull
	7	130	—
Manaia River	3	16	—
	5	430	Ruminant, human, possum, pig
	7	80	—
Te Mata Stream	3	21	—
	5	330	Ruminant, human, possum, pig
	7	30	—
Te Puru Stream	3	12	—
	5	160	Ruminant, possum
	7	800	Possum
Pitoone Stream	3	3100	**Ruminant**, cow, human, possum, gull
	5	2700	**Ruminant**, **cow**, **human**, possum
	7	270	Ruminant, possum, gull
Kuaotunu River	3	1200	**Ruminant**, **cow**, **human**, possum, gull
	5	5500	**Ruminant**, **cow**, **human**, possum, pig
	7	900	Ruminant, cow, possum
Otama Stream	3	110	Possum, gull
	5	5000	**Ruminant**, **human**, possum, pig
	7	500	**Ruminant**, **cow**, human, possum, pig
Stewart Stream	3	500	Ruminant, **human**, possum, gull
	5	6500	Ruminant, cow, **human**, possum
	7	1200	Ruminant, possum, gull
Tohetea Stream	3	600	Ruminant, possum, gull
	5	2700	**Ruminant**, **cow**, possum, gull
	7	110	Ruminant, possum
Tarapatiki Stream	3	5400	**Ruminant**, **cow**, human, possum, gull
	5	4100	**Ruminant**, cow, **human**, possum, gull
	7	4000	Ruminant, possum, gull
Taputapuatea Stream	3	2900	Possum
	5	1500	Ruminant, cow, possum, gull
	7	3300	Possum, gull
Purangi River	3	18	—
	5	4	Possum, gull

	7	10	—
Wigmore Stream	3	1700	Ruminant, cow, **human**, possum, gull
	5	1500	Ruminant, possum, gull
	7	120	—
Taiwawe Stream	3	49	—
	5	320	Ruminant, **cow**, human, possum, gull
	7	210	—
Grahams Creek	3	420	Ruminant, cow, possum, gull
	5	900	**Ruminant**, **cow**, **human**, possum, gull, pig
	7	500	Ruminant, possum, gull
Pepe Stream	3	5600	Ruminant, possum, gull
	5	1100	Ruminant, possum, gull, pig
	7	50	—
Otahu River	3	3	—
	5	1200	Human, possum, gull
	7	10	—
Te Ramarama Stream	3	54	—
	5	3500	Ruminant, **cow**, human, gull
	7	2100	Ruminant, possum, gull

3.3 Influence of rainfall, river flow, tide height, and catchment land use on stream mouth water quality

This section explores relationships between enterococci concentration and rainfall (Figure 5, Table 5 and 7), river flow (Figure 5, Table 7), and tide height (Figure 4, Table 7).

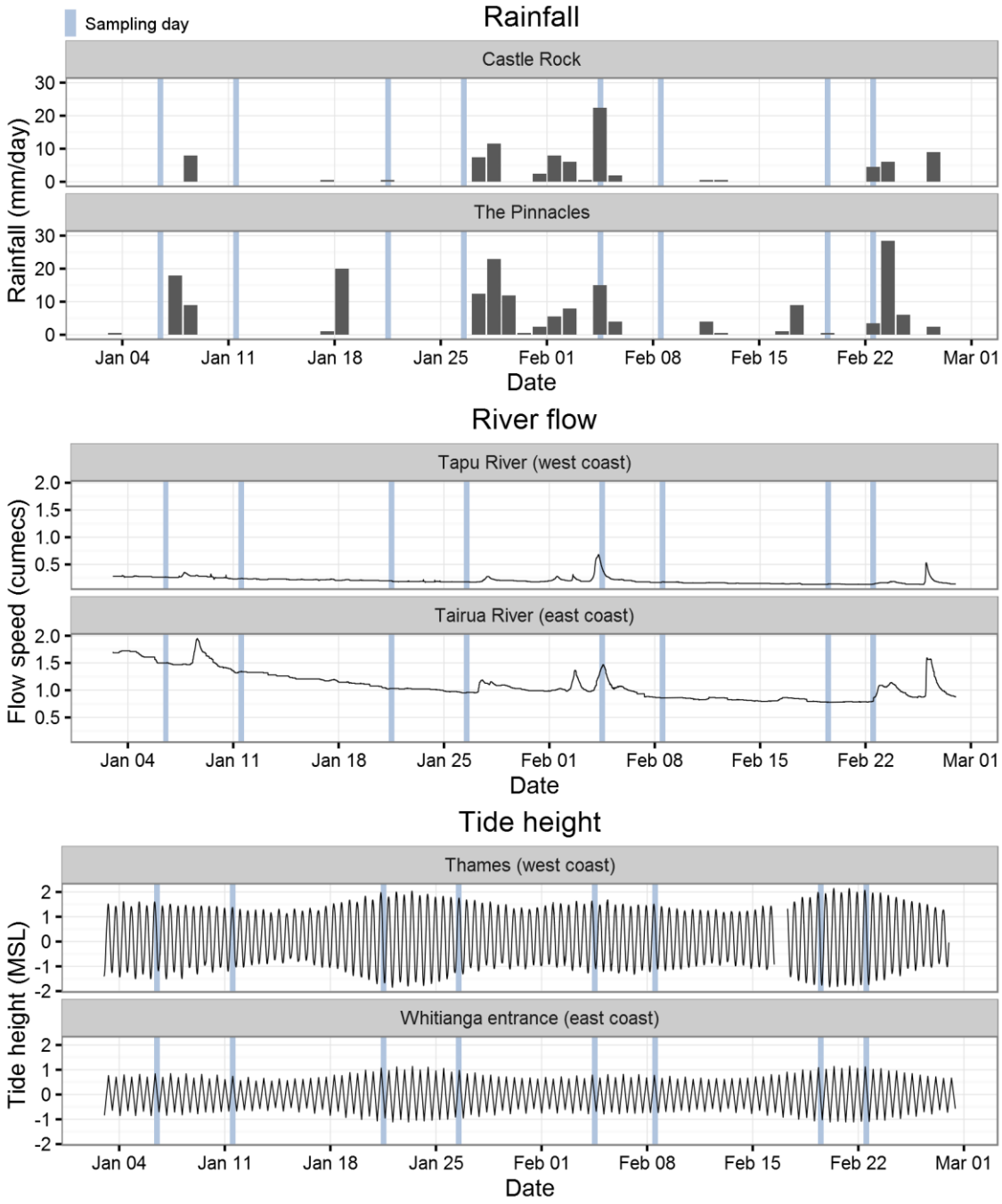

Figure 5: **Rainfall, river flows, and tide heights from representative sites on the west and east coast of the Coromandel area. Stream mouth sampling days are indicated by the vertical blue bars. Rainfall was measured at two Waikato Regional Council monitoring sites, Castle Rock and the Pinnacles. River flows were measured at two Waikato Regional Council monitoring sites: Tapu River and Tairua River. Tide heights for Thames were measured at the Waikato Regional Council tide gauge and the tide heights for Whitianga entrance were calculated by the NIWA tide forecaster[2].**

[2] https://www.niwa.co.nz/services/online-services/tide-forecaster

The highest bacterial concentrations around the Coromandel area were detected during sampling weeks three, five, and seven. Visual inspection of Figure 5 reveals that water sampling during week five coincided with heavy rainfall and increased river flows. The other two weeks with elevated bacterial levels, weeks three and seven, did not have increased rainfall or river flow, but water sampling coincided with an increasing spring tide on both occasions.

3.3.1 Rainfall

Heavy rainfall is one likely cause for elevated nutrient and bacterial levels in stream mouths. Following a heavy rainfall event, many nutrients and contaminants are washed from the land into waterways. Common sources of nutrients and bacteria include effluent run-off from farmland, human wastewater discharges, stormwater outfalls, and domestic and wild animal waste.

Rainfall measurements from Waikato Regional Council's monitoring station on Castle Rock were used to investigate the relationship between rainfall and enterococci concentrations at stream mouths in the Coromandel area (Table 5). It is important to note that only eight data points are used to calculate each relationship and this limits the statistical ability to identify the true extent of these relationships.

Table 5: Summary table of the correlation between rainfall at Castle Rock in the 24 hours prior to sampling the stream mouth and enterococci concentration measured in the sample at each study site. A linear fit was added for each site using rainfall as the predictor of enterococci concentration. Statistically significant fits are indicated in bold (p <0.05).

Site	R^2	p
Whangarahi Stream	0.324	0.140
Manaia River	**0.745**	**0.006**
Te Mata Stream	**0.557**	**0.034**
Te Puru Stream	0.001	0.932
Pitoone Stream	0.332	0.135
Kuaotunu River	**0.828**	**0.002**
Otama Stream	**0.972**	**<0.001**
Stewart Stream	**0.914**	**<0.001**
Tohetea Stream	**0.889**	**<0.001**
Tarapatiki Stream	0.145	0.352
Taputapuatea Stream	0.005	0.865
Purangi River	0.062	0.551
Wigmore Stream	0.338	0.131
Taiwawe Stream	0.413	0.086
Grahams Creek	**0.655**	**0.015**
Pepe Stream	0.002	0.922
Otahu River	**0.959**	**<0.001**
Te Ramarama Stream	**0.651**	**0.015**

The analysis revealed that cumulative rainfall at Castle rock, that is, the total rainfall in the 24 hours preceding sample collection, had a statistically significant relationship with the measured enterococci concentration at nine of the 18 sites (Table 5).

At these sites, rainfall described approximately 50–90% of the variation in enterococci concentration in the water sampled at the stream mouth, depending on the site. This means

that, depending on the location, 50–90% of changes in enterococci concentrations can be explained by the amount of rain that has fallen in the past 24 hours.

This also highlights that the effect of rainfall on enterococci concentration differed among sites, that is, some sites were more susceptible to elevated enterococci concentrations following rainfall than others. One factor to consider is that some streams may be spring fed and are therefore influenced less by rainfall.

3.3.2 Tide height

Elevated levels of bacteria were also detected throughout the Coromandel area during sampling periods that did not coincide with heavy rainfall. During two of these sampling weeks (three and seven) sampling coincided with an increasing spring tide.

During high tide periods, enterococci on low-lying land may be washed into the marine area. Furthermore, exceptionally high tides may flood septic tanks, washing sewage into the waterways. This survey did not investigate whether these potential causes were of any relevance at the sampling sites.

Analysis of tide data revealed that the maximum tide height is a poor predictor of the enterococci concentration in the stream mouths (Table 6). This means that maximum tide height cannot be used on its own to estimate or describe enterococci concentration in the stream mouths.

Table 6: **Results of the ANCOVA exploring the effect of tide height on enterococci concentration per site. Tide heights from Thames were used for sites on the west coast of the Coromandel area and tide heights from the NIWA forecaster for Whitianga were used for sites on the east coast. Enterococci concentration = Max tide height + Site; Adjusted R^2 = 0.08, p = 0.05.**

	Df	Sum Sq	Mean Sq	*F* value	*p*
Max tide height	1	53238	53238	0.04	0.847
Site	17	43125032	2536767	1.79	**0.037**
Residuals	125	177630653	1421045		

However, when the factors tide and rainfall were combined, interesting patterns and statistically significant relationships were observed. This analysis revealed that the effect of rainfall on enterococci concentration was influenced by the maximum tide height, as indicated by the statistically significant interaction between rainfall and tide height (Table 7). This means that at some locations, high tides may exacerbate the concentration of enterococci that is washed into coastal stream mouths following heavy rainfall.

Table 7: **Results of the ANCOVA used to investigate the effect of rainfall (Castle Rock), tide height, and the interaction between these parameters on the enterococci concentration at the 18 sampling sites. Enterococci concentration = Site + Rainfall + Tide + Site:Rainfall + Rainfall:Tide. Adjusted R^2 = 0.667, p < 0.001.**

	Df	Sum Sq	Mean Sq	*F* value	*p*
Site	17	43166948	2539232	3.66	**<0.001**
Rainfall	1	41793632	41793632	60.22	**<0.001**
Tide	1	2025031	2025031	2.92	0.090
Site:Rainfall	17	51773424	3045496	4.39	**<0.001**
Rainfall:Tide	1	8482750	8482750	12.22	**<0.001**
Residuals	106	73567137	694030		

3.3.3 Land use

Site catchments located in west Coromandel (Whangarahi Stream to Te Puru Stream) had the greatest proportion of native forest of all the sites in the study (Figure 6). These sites also contained relatively small areas allocated for drystock and no area allocated to dairy farming.

Contrastingly, sites in east Coromandel had higher proportions of the catchment allocated to dairy and drystock. This also means that east Coromandel catchments had lower proportions of native forest.

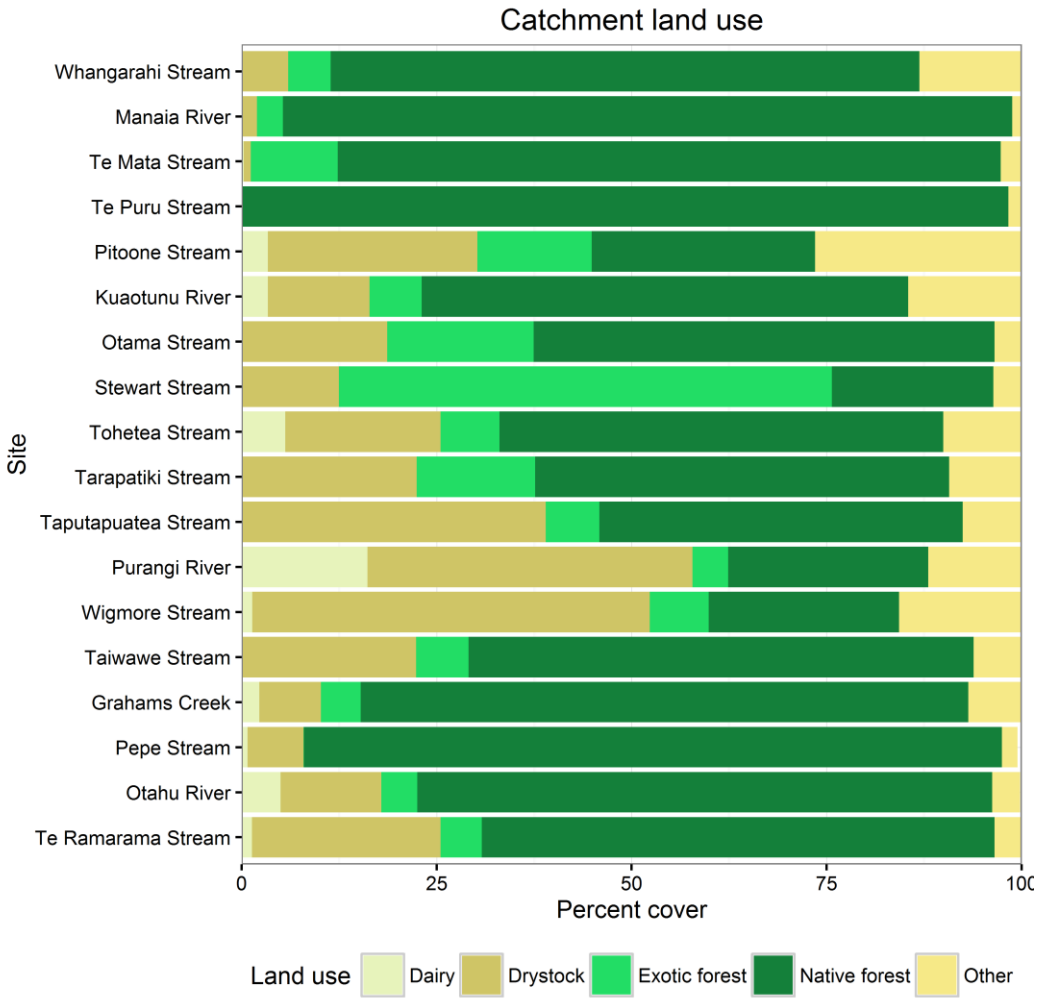

Figure 6: Catchment land use as a percentage of total catchment area. Land use information was collated from the land cover database (Landcare Research New Zealand Ltd.) and AgriBase (AsureQuality).

4 Discussion

This snapshot of coastal stream mouth water quality over January and February 2015 in the Coromandel area revealed that these water bodies were very susceptible to contaminants washed from the land, particularly following heavy rainfall and during spring tides.

In many cases, nutrient concentrations exceeded AZNECC guideline values by relatively small amounts; however, some exceedances were over 100 times greater than the guideline value. Further investigation at these sites will be necessary to determine the cause, frequency, and environmental effect, if any, of such exceedances.

Similarly, bacterial concentrations were usually below the recreational guideline value but, on occasion, enterococci concentrations exceeded the recreational water quality guideline by up to 20 times at some locations. Across all sampling sites, the greatest exceedances of nutrient and bacterial guideline values coincided with spring (high) tide or following a heavy rainfall event.

Although the greatest exceedance of nutrient and bacterial concentrations coincided with heavy rainfall and high tides, statistically, rainfall in the 24 hours preceding sampling was not a suitable predictor of nutrient or bacterial concentrations at all locations. This is possibly linked to the Coromandel area's complex topography. Rainfall that occurs on the mountain ranges, where the rainfall was measured, may not result in increased river flows at every stream mouth. Typically, rainfall on the mountain ranges may result in land-based contaminants being flushed from some catchments, or sub-catchments into nearby waterways, but not all simultaneously. Rainfall may take longer than 24 hours to reach the mouth of the longer rivers. Furthermore, contaminant concentrations are typically highest during the early stages of the rainfall event and diminish as the rainfall continues. Sampling water weekly is likely to miss the peak contaminant concentration following rainfall event. Targeted investigations would be better suited for determining bacterial loading into waterways following heavy rainfall events.

The effect of rainfall following an extended period of dry weather on nutrient and bacterial concentrations was not investigated during this study, but can have a large effect on coastal stream mouth water quality. During dry periods, contaminants accumulate on the land, which can then be washed into waterways during a heavy rain event over a short amount of time, resulting in a 'pulse' of contaminants in the water. A routine (weekly) sampling programme is likely to miss collecting samples during or immediately following such events unless the programme is designed specifically to accommodate this. The concentration of nutrients and bacteria in the water can change rapidly, so sampling a stream mouth 48 hours, for example, after a heavy rain event may not reveal the magnitude of contaminants washed into the waterway. In a long-term monitoring programme, this may lead to an underestimation of the total contaminant load that is discharged into the marine environment.

The effect of catchment land use on water quality is another factor that should be further investigated. Catchment land use is shown in Figures 1 and 6 for reference, but a detailed analysis was not included in this report. A pattern than emerged from the data was that locations on the west coast of the Coromandel generally had better water quality (less nutrients and lower bacterial concentrations) than locations on the east coast of the Coromandel. The west coast of the Coromandel is less developed than that of the east, and there are potentially some parameters, such as percentage land cover of native forest and population of localities during summer, that could provide an estimate of the total contaminant load into coastal stream mouths following heavy rainfall.

4.1 Microbial source tracking

Faecal markers for ruminant animals appeared to be the most dominant and most frequently identified at most sites. Bacteria originating from cows were not always detected at these sites with high ruminant marker counts. This may indicate that other animals, such as sheep, were contributing to the bacterial loads in these catchments at the time of sampling. This scenario

was most commonly observed at sites on the west coast, including Whangarahi Stream, Manaia River, and Te Mata Stream, which had no land allocated to dairy farming (Figure 1). Alternatively, the ruminant and cow specific tests target different bacteria that have different detection limits, and therefore, differences in these tests may reflect the difference in the minimum detectable amount of faecal contamination from each source.

Human markers were identified at some sites in weeks three and five, with week five having the most sites test positive for the marker. The increasing spring tide during week three and the heavy rainfall associated when sampling in week five appear to be key factors influencing the presence of human faecal bacteria at the stream mouth. Heavy rainfall may wash contaminants from the catchment into the waterways; additionally, heavy rainfall and high tides may flood low-lying land and wash further contaminants into the waterways. Septic tanks in these low lying areas may also be susceptible to flooding and releasing some of their contents into the surrounding areas, however, this study has not endeavoured to assess such effects. Furthermore, ground saturation following heavy rainfall or flooding may reduce the soil retention time of land based contaminants and septic tank discharge resulting in higher concentrations of faecal indicator bacteria in nearby waterways.

One of the main limitations with microbial source tracking is that individual tests must be run for each marker. This means only the bacteria that are tested for, or which tests are available, are found. For example, Taputapuatea Stream had relatively high concentrations of the general bacteroides marker but the other markers were low, which prevented identification of the specific sources of the faecal contamination. Ruminant and cow bacterial sources were only detected in week five and these counts were relatively low compared to other locations with similar general bacteroides counts. In weeks three and seven, only possum and gull markers were identified in Taputapuatea Stream and these markers are semi-quantitative and qualitative, respectively. In this situation, additional markers would need to be run to attempt to identify the source of faecal bacteria in this stream mouth. It is unlikely that a comprehensive suite of markers would be run on samples from a typical monitoring or investigative programme as there is an additional analysis cost for each additional marker. This means it is likely a substantial source of faecal bacteria may be overlooked.

Under specific conditions, enterococci multiply from natural sources such as decaying leaf matter. With the methodology and markers used in this study, microbial source tracking would not have been able to identify when and where this took place. This is important because this situation can result in elevated enterococci concentrations that have little or no correlation with pathogens, even in pristine waters (MfE/MoH, 2003).

4.2 Recommendations for future development and implementation of microbial source tracking

Microbial source tracking has shown to be a promising complementary approach for the assessment of water quality in the Waikato region coastal marine area. The additional analysis cost may restrict the use of the technique on a routine basis; however, adopting a staged water quality analysis approach, such as the one used in this study, may make this more achievable. Filtering a water sample at the same time as conducting other analyses and freezing the filter paper is a cost effective method to keep microbial source tracking analysis as an option once other, standard monitoring criteria are exceeded to warrant further analysis.

Further development is required for the technique to provide information necessary to make robust resource management decisions. Identification of possible sources of faecal contamination — and just as importantly, identifying sources that are absent — is useful, but more effective plans could be made if the results were quantitative or semi-quantitative so that comparisons could be made between markers. For example, the possum marker was frequently identified at many of the sampling sites but its contribution to the total faecal load could not be determined. The contribution towards the total faecal bacteria load may determine management priorities. One approach to further developing the microbial source

tracking approach for use by Waikato Regional Council may be to include multiple tracking techniques, such as faecal sterol analysis, fluorescent whitening agent analysis, or library-based methods to confirm contamination sources.

Faecal contamination from possums was frequently identified at most locations. The ruminant and the human bacteroides markers have been shown to cross-react with faecal material from brushtail possums (Devane et al. 2013; Kirs et al. 2011). This could result in overestimating the contribution of faecal material from ruminant animals or from humans in catchments with a substantial possum population such as the Coromandel area, which comprises large proportions of native bush. Further investigation into the magnitude of the effect of this cross-reactivity in these catchments is recommended.

Once the technique has been further developed, guidance documentation on the best sampling method for microbial source tracking would ensure that results provide the most accurate representation of the environment. The documentation should cover aspects such as how to sample when there are people in the water nearby or upstream from the sampling site. An investigation into the effect of such activity on the final human marker counts would be useful for developing a microbial source tracking sampling 'best practice'.

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Appendix A – Water quality parameters and tide times

Table A-1: Summary of marine water quality parameters, units, detection limits, analysis methods, and sources of data.

Parameter	Unit	Detection limit	Method	Source
Dissolved oxygen	mg/L	0.1	Handheld meter (Hach HQ30d + LDO101)	Field
Dissolved oxygen saturation	%	—	Handheld meter (Hach HQ30d + LDO101)	Field
Temperature	°C	—	Handheld meter (Hach HQ30d + LDO101)	Field
Turbidity	NTU	0.05	APHA (2012) 2130 B	Lab
Salinity	ppt	0.2	APHA (2012) 2520 B	Lab
Total suspended solids	g/m^3	3	APHA (2012) 2540 D	Lab
Total nitrogen	g/m^3	0.05	Calculation: TKN + Nitrate-N + Nitrite-N	Lab
Total ammoniacal-N	g/m^3	0.01	APHA (2012) 4500-NH3 F (modified)	Lab
Nitrate-N + nitrite-N	g/m^3	0.002	APHA (2012) 4500-NO3- I	Lab
Total Kjeldahl nitrogen (TKN)	g/m^3	0.05	APHA (2012) 4500-Norg D (modified); 4500 NH3 F (modified)	Lab
Dissolved reactive phosphorus (DRP)	g/m^3	0.004	APHA (2012) 4500-P E (modified)	Lab
Faecal coliforms	cfu/100 mL	1	APHA (2012) 9222 D	Lab
Escherichia coli	cfu/100 mL	1	APHA (2012) 9222 G	Lab
Enterococci	cfu/100 mL	1	APHA (2012) 9230 C (modified)	Lab

Table A-2: **Times of high and low tides on sampling days (Whitianga, NZST). Tide times were taken from Land Information New Zealand tide prediction tables for Whitianga[3]. Samples were collected in two runs, which were not always conducted on the same day. Run 1 included Whangarahi Stream, Manaia River, Te Mata Stream, Te Puru Stream, Purangi River, Wigmore Stream, Taiwawe Stream, Grahams Creek, Pepe Stream, Otahu River, and Te Ramarama Stream; Run 2 included Pitoone Stream, Kuaotunu River, Otama Stream, Stewart Stream, Tohetea Stream, Tarapatiki Stream, and Taputapuatea Stream.**

Week	Date	Run 1	Run 2	High tide	Low tide
1	7/01/2015	✓		8:34	14:34
	8/01/2015		✓	9:15	15:16
2	12/01/2015	✓		11:54	17:57
	19/01/2015		✓	5:37	11:32
3	22/01/2015	✓	✓	8:16	14:15
4	27/01/2015	✓	✓	12:35	18:39
5	5/02/2015	✓	✓	8:08	14:10
6	9/02/2015	✓	✓	10:42	16:43
7	20/02/2015	✓	✓	7:53	13:54
8	23/02/2015	✓	✓	10:23	16:31

[3] http://www.linz.govt.nz/sea/tides/tide-predictions

Appendix B – Microbial source tracking methods

Thank you to Jonathan Banks (Cawthron) for providing the following microbial source tracking analysis details.

In the laboratory, 300 mL of water was filtered through a 0.45 µm pore, 47 mm diameter mixed cellulose ester filter (Catalogue number A045H047A, Advantec, Japan). DNA was extracted from the filter using a Mo Bio Power Soil DNA isolation kit (Mo Bio Laboratories, Inc., Carlsbad, Catalogue number 12888-100) following the manufacturer's protocol. DNA was re-suspended in 100 µL of elution buffer.

DNA from host-specific bacteria was amplified using polymerase chain reactions containing 10 µL of Express qPCR mix (Life, Carlsbad, catalogue number A10312). 0.1 nmol of each primer (IDT, Singapore, 10 µm/L), 2 pmol of the hydrolysis probe (IDT, Singapore, 10 µmol/L), 5.8 µL of HPLC grade water (Invitrogen, Grand Island, catalogue number 10977) and 2 µL of template DNA. Primer and probe sequences are listed in Table 8.

Reactions were prepared in a laminar flow cabinet in a dedicated preparation room isolated from DNA template and PCR product processing areas. Polymerase chain reaction were run on a Rotor-Gene Q thermalcycler (Qiagen, Venlo) with a temperature profile of an initial hold at 50 °C for 2 minutes followed by a hold at 95 °C for 2 minutes, and then 40 cycles at 95 °C for 15 seconds followed by 60 °C for one minute. Relative number of gene copies were estimated using the Rotor-gene Q software to calculate standard curves from differing concentrations of plasmids containing the relevant insert.

Table 8: Sequences of primers and hydrolysis probes used to identify the presence of host specific bacteria from water samples.

Name	Sequence	Target	Reference
BacUF	GGG GTT CTG AGA GGA AGG T	Universal Bacteroides	(Siefring et al. 2008)
GenBacR4	CCG TCA TCC TTC ACG CTA CT		(Siefring et al. 2008)
Probe	FAM-CAATATTCCTCACTGCTGCCTCCCGTA-BHQ		(Siefring et al. 2008)
Hum 3F	GTAATTCGCGTTCTTCCTCACAT	Human specific Bacteroides	(Shanks et al. 2009)
Hum 3R	GGAGGAAACAAGTATGAAGATAGAAGAATTAA		(Shanks et al. 2009)
Probe	FAM-AGGTCTGTCCTTCGAAATAGCGGT-BHQ		(Shanks et al. 2009)
Cow M2F	CGG CCA AAT ACT CCT GAT CGT	Cow specific Bacteroides	(Shanks et al. 2008)
Cow M2R	GCT TGT TGC GTT CCT TGA GAT AAT		(Shanks et al. 2008)
Probe	FAM-AGG CAC CTA TGT CCT TTA CCT CAT CAA CTA CAG ACA-BHQ		(Shanks et al. 2008)
P56F	TGC AAG TCG AGG GGT AAC AG	Possum specific Batceroidales	Devane et al (2013)
P208R	TAA GGA GAC CAT GCG GAA TC		
Gull 2F	TGC ATC GAC CTA AAG TTT TGA G	Gull specific *Catellicoccus marimammalium*	Lu et al (2008)
Gull 2R	GTC AAA GAG CGA GCA GTT ACT A		

DF475F	CGC TTG TAT GTA CCG GTA CG	Dog specific Bacteroidales	Dick et al (2005b)
Bac 708R	CAA TCG GAG TTC TTC GTG	Bacteroidales	Bernhard and Field (2000)
PF163F	GCG GAT TAA TAC CGT ATG A	Pig specific Bacteroidales	Dick et al. (2005a)
Bac 708R	CAA TCG GAG TTC TTC GTG	Bacteroidales	Bernhard and Field (2000)

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Appendix C – Water quality results

The following tables present results from weekly water quality analyses at 18 stream mouths in the Coromandel area during January and February, 2015. Water quality parameters are presented in two tables per site, one for ecological health and the other for human health.

Estuarine water quality guideline values are presented with each variable where applicable. Ecological health guidelines values are obtained from the ANZECC (2000) guidelines. It is important to note that the exceedance of a guideline value does not imply that there are adverse environmental effects. Its purpose is to trigger more detailed investigations at that location to identify possible causes for the exceedance and determine whether there are any adverse effects.

Recreational health guidelines are obtained from the MfE (2003) recreational water quality guidelines. Enterococci, rather than *E. coli*, are the primary indicator of recreational health in coastal and estuarine environments.

To calculate medians, a result that is below detection limit is deemed to have a value of half the detection limit; e.g. a result presented as <0.2 g/m^3 is assumed to be 0.1 g/m^3.

Microbial source tracking was conducted on samples from weeks three, five, and seven at sites with enterococci concentrations typically >150 cfu/100 mL. Some sites with enterococci concentrations <150 cfu/100 mL were also included from these weeks as they were sent for analysis in error. The grey coloured cells indicate that those samples were not tested with microbial source tracking assays.

Results for the general bacteroides, ruminant, and human markers are presented as gene copies per reaction; a larger number indicates a higher concentration of the marker. The results for the possum assays are provided as a Ct value which is the cycle number at which fluorescence reaches a threshold of 0.026 fluorescence units (up to a maximum of 40 cycles). A smaller number indicates a higher concentration of the possum marker; an increase of 3.3 cycles is equivalent to a 10 fold decrease in DNA concentration. Gull, dog, and pig markers only reveal the presence (+) or non-detection (−) of each source.

Whangarahi Stream – Coromandel Town

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
7/01/2015 14:17	27.3	2.8	2.0	< 3	141	1.34	1.100	0.250	1.590	< 0.004
12/01/2015 17:40	25.4	2.9	3.5	6	120	0.55	0.500	0.230	0.770	< 0.004
22/01/2015 0:00	—	4.9	3.2	6	—	0.53	0.480	0.210	0.740	< 0.004
27/01/2015 18:03	21.8	7.6	9.6	22	105	2.30	2.100	0.280	2.600	< 0.004
5/02/2015 14:05	—	2.8	11.8	20	—	0.73	0.460	0.144	0.880	0.007
9/02/2015 15:35	22.8	9.0	9.9	21	148	0.67	0.510	0.136	0.800	< 0.004
20/02/2015 13:30	24.7	9.7	5.1	63	132	1.92	1.700	0.230	2.200	< 0.004
23/02/2015 17:18	23.9	5.8	73.0	127	114	1.75	1.400	0.220	1.980	< 0.004
Median	24.3	5.4	7.4	21	126	1.04	0.805	0.225	1.235	0.002
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
7/01/2015 14:17	31	100	140								
12/01/2015 17:40	180	390	500								
22/01/2015 0:00	9	340	390								
27/01/2015 18:03	210	310	450								
5/02/2015 14:05	290	510	580	45000	1800	0	2	28.4	+	−	−
9/02/2015 15:35	170	420	460								
20/02/2015 13:30	130	340	400								
23/02/2015 17:18	47	1300	1700								
Median	150	365	455								
Guideline value (contact recreation)	280	—	—								

Manaia River – Manaia

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
7/01/2015 14:39	24.8	< 0.2	1.2	< 3	107	0.06	< 0.010	< 0.002	0.060	< 0.004
12/01/2015 18:05	25.1	< 0.2	1.4	< 3	105	0.07	< 0.010	< 0.02	0.070	< 0.004
22/01/2015 0:00	—	0.2	1.2	< 3	—	0.07	< 0.010	< 0.002	0.070	< 0.004
27/01/2015 18:25	21.4	0.7	1.5	< 3	99	0.08	< 0.010	< 0.002	0.080	< 0.004
5/02/2015 14:25	—	< 0.2	4.3	< 3	—	0.21	< 0.010	< 0.002	0.210	< 0.004
9/02/2015 16:31	22.7	< 0.2	1.1	< 3	108	< 0.05	< 0.010	< 0.002	< 0.060	< 0.004
20/02/2015 13:55	22.3	0.8	1.9	< 3	118	< 0.05	< 0.010	< 0.002	0.050	0.004
23/02/2015 17:52	22.8	0.4	1.7	< 3	97	0.08	< 0.010	< 0.002	0.080	< 0.004
Median	22.8	0.2	1.4	2	106	0.07	0.005	0.001	0.07	0.002
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
7/01/2015 14:39	25	53	80								
12/01/2015 18:05	40	110	120								
22/01/2015 0:00	16	60	80								
27/01/2015 18:25	70	80	90								
5/02/2015 14:25	430	310	340	4100	340	0	2	28.5	−	−	+
9/02/2015 16:31	120	110	130								
20/02/2015 13:55	80	90	110								
23/02/2015 17:52	330	470	580								
Median	75	100	115								
Guideline value (contact recreation)	280	—	—								

Te Mata Stream – Te Mata

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
7/01/2015 15:06	25.8	1.1	1.8	< 3	108	0.09	< 0.010	0.007	0.100	< 0.004
12/01/2015 18:37	23.8	< 0.2	1.6	4	103	0.11	< 0.010	0.005	0.110	< 0.004
22/01/2015 0:00	—	2.2	0.5	< 3	—	0.11	< 0.010	0.008	0.120	< 0.004
27/01/2015 18:59	22.2	1.3	1.0	< 3	102	0.10	< 0.010	0.007	0.110	< 0.004
5/02/2015 15:00	—	< 0.2	1.5	< 3	—	0.15	< 0.010	< 0.002	0.160	< 0.004
9/02/2015 17:04	22.4	< 0.2	0.5	< 3	112	0.06	< 0.010	0.004	0.060	< 0.004
20/02/2015 14:26	24.8	3.4	0.7	< 3	107	0.11	< 0.010	0.013	0.120	< 0.004
23/02/2015 18:19	21.3	2.3	0.4	< 3	107	0.07	< 0.010	0.009	0.080	< 0.004
Median	23.1	1.2	0.9	2	107	0.11	0.005	0.007	0.11	0.002
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
7/01/2015 15:06	230	170	180								
12/01/2015 18:37	54	160	160								
22/01/2015 0:00	21	50	80								
27/01/2015 18:59	100	42	56								
5/02/2015 15:00	330	170	180	1900	110	0	3	30.5	−	−	+
9/02/2015 17:04	90	70	120								
20/02/2015 14:26	30	180	210								
23/02/2015 18:19	40	70	80								
Median	72	115	140								
Guideline value (contact recreation)	280	—	—								

Te Puru Stream – Te Puru

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
7/01/2015 15:26	25.8	< 0.2	1.1	< 3	110	0.06	< 0.010	< 0.002	0.060	< 0.004
12/01/2015 18:59	22.4	< 0.2	0.7	< 3	106	0.07	< 0.010	< 0.002	0.080	< 0.004
22/01/2015 0:00	—	0.6	0.6	< 3	—	0.07	< 0.010	< 0.002	0.070	< 0.004
27/01/2015 19:18	21.0	0.3	0.7	< 3	96	0.14	< 0.010	< 0.002	0.140	< 0.004
5/02/2015 15:20	—	< 0.2	2.2	3	—	0.17	< 0.010	< 0.002	0.170	< 0.004
9/02/2015 17:30	20.3	0.2	0.4	< 3	108	< 0.05	< 0.010	< 0.002	< 0.060	< 0.004
20/02/2015 15:03	23.7	0.5	56.0	58	102	0.06	< 0.010	0.002	0.070	< 0.004
23/02/2015 19:03	20.9	0.6	1.1	< 3	94	0.08	< 0.010	< 0.002	0.080	< 0.004
Median	21.7	0.3	0.9	2	104	0.07	0.005	0.001	0.075	0.002
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
7/01/2015 15:26	110	20	40								
12/01/2015 18:59	15	270	340								
22/01/2015 0:00	12	90	120								
27/01/2015 19:18	150	100	130								
5/02/2015 15:20	160	30	80	1300	22000	0	0	31.3	–	–	–
9/02/2015 17:30	34	40	80								
20/02/2015 15:03	800	500	800	14000	0	0	0	30.6	–	–	–
23/02/2015 19:03	260	210	290								
Median	130	95	125								
Guideline value (contact recreation)	280	—	—								

Pitoone Stream – Pitoone

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m³)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m³)	Total ammoniacal-N (g/m³)	Nitrate-N + nitrite-N (g/m³)	Total nitrogen (g/m³)	Dissolved reactive phosphorus (g/m³)
8/01/2015 11:54	25.9	3.1	5.3	5	95	0.27	0.020	0.011	0.280	< 0.004
19/01/2015 11:08	26.0	19.5	5.1	12	84	0.21	< 0.010	0.008	0.220	0.004
22/01/2015 11:30	20.8	29.0	1.7	7	91	0.12	0.120	< 0.200	< 0.300	0.006
27/01/2015 15:47	22.8	15.0	2.7	3	106	0.16	< 0.010	0.012	0.170	< 0.004
5/02/2015 10:57	21.6	10.6	13.1	20	94	0.32	0.037	0.054	0.380	0.006
9/02/2015 14:10	23.1	16.0	3.0	6	100	0.16	< 0.010	0.015	0.170	< 0.004
20/02/2015 10:48	22.4	2.7	2.9	4	85	0.21	< 0.010	< 0.020	0.210	0.005
23/02/2015 14:15	23.1	20.0	5.4	9	89	0.38	< 0.010	< 0.020	0.380	0.013
Median	23	15.5	4.1	7	92	0.21	0.005	0.012	0.215	0.005
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
8/01/2015 11:54	18	280	520								
19/01/2015 11:08	230	490	520								
22/01/2015 11:30	3100	800	1200	25000	31000	120	1	29.9	+	−	−
27/01/2015 15:47	160	300	500								
5/02/2015 10:57	2700	2400	2900	59000	78000	550	13	26.9	−	−	−
9/02/2015 14:10	100	180	190								
20/02/2015 10:48	270	490	530	10000	6800	0	0	35.2	+	−	−
23/02/2015 14:15	360	560	580								
Median	250	490	525								
Guideline value (contact recreation)	280	—	—								

Kuaotunu River – Kuaotunu

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
8/01/2015 11:38	18.7	17.8	1.7	5	97	0.18	0.104	0.051	0.230	0.016
19/01/2015 9:14	22.2	11.4	3.7	5	71	0.14	0.033	0.022	0.160	0.008
22/01/2015 11:12	20.3	26.0	3.5	6	85	0.21	0.069	0.045	0.250	0.024
27/01/2015 15:26	21.7	28.0	4.2	8	97	0.09	0.115	0.053	0.140	0.022
5/02/2015 10:38	20.8	13.9	6.1	11	93	0.22	0.011	0.018	0.240	0.014
9/02/2015 13:50	22.0	13.8	2.0	5	111	0.13	0.022	0.016	0.150	0.006
20/02/2015 10:25	21.1	32.0	1.6	< 3	87	0.17	0.131	0.020	0.190	0.022
23/02/2015 13:37	22.9	31.0	1.7	9	88	0.11	0.051	0.020	0.140	0.014
Median	21.4	21.9	2.8	6	90	0.16	0.060	0.021	0.175	0.015
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
8/01/2015 11:38	230	220	640								
19/01/2015 9:14	1600	2300	2300								
22/01/2015 11:12	1200	1000	1400	120000	58000	200	7	31.1	+	−	−
27/01/2015 15:26	330	130	150								
5/02/2015 10:38	5500	2800	3500	68000	150000	230	18	26.9	−	−	+
9/02/2015 13:50	190	230	360								
20/02/2015 10:25	900	1800	1800	8600	7600	130	0	34.0	−	−	−
23/02/2015 13:37	58	580	590								
Median	615	790	1020								
Guideline value (contact recreation)	280	—	—								

Otama Stream – Otama Beach

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
8/01/2015 11:12	19.1	35.0	0.7	4	103	0.16	0.240	< 0.020	0.170	0.006
19/01/2015 10:34	24.7	7.7	2.4	3	101	0.26	< 0.010	< 0.002	0.260	< 0.004
22/01/2015 10:52	22.6	9.3	1.8	4	87	0.34	< 0.010	< 0.200	0.400	< 0.004
27/01/2015 15:07	23.6	20.0	2.7	4	126	0.37	< 0.010	< 0.200	0.400	< 0.004
5/02/2015 10:11	21.5	7.6	4.6	10	84	0.38	0.013	0.007	0.390	< 0.004
9/02/2015 13:26	21.2	35.0	0.7	4	110	0.21	0.141	< 0.020	0.210	0.006
20/02/2015 9:57	21.2	10.8	3.2	6	92	0.26	< 0.010	< 0.020	0.260	< 0.004
23/02/2015 13:08	23.8	17.8	1.7	3	96	0.37	< 0.010	< 0.020	0.380	< 0.004
Median	22.1	14.3	2.1	4	99	0.30	0.005	0.010	0.320	0.002
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
8/01/2015 11:12	5	2	2								
19/01/2015 10:34	90	200	200								
22/01/2015 10:52	110	110	120	5700	0	0	0	32.1	weak	−	−
27/01/2015 15:07	32	40	50								
5/02/2015 10:11	5000	3500	4600	22000	38000	0	17	28.3	−	−	+
9/02/2015 13:26	5	6	6								
20/02/2015 9:57	500	1600	1600	38000	150000	280	3	31.2	−	−	+
23/02/2015 13:08	410	260	270								
Median	100	155	160								
Guideline value (contact recreation)	280	—	—								

Stewart Stream – Opito Bay

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
8/01/2015 10:45	27.2	8.3	2.8	5	119	0.25	< 0.010	< 0.002	0.250	< 0.004
19/01/2015 9:58	24.3	1.0	4.9	6	72	0.21	< 0.010	< 0.002	0.210	< 0.004
22/01/2015 10:19	21.3	2.5	3.9	5	87	0.19	< 0.010	< 0.200	< 0.300	< 0.004
27/01/2015 14:43	23.7	12.4	10.3	5	88	0.16	< 0.010	< 0.200	< 0.300	< 0.004
5/02/2015 9:40	22.7	3.2	12.0	14	35	0.35	< 0.010	0.019	0.370	0.006
9/02/2015 13:04	25.8	2.4	4.5	4	73	0.25	< 0.010	< 0.020	0.250	0.004
20/02/2015 9:25	25.5	1.4	3.3	< 3	87	0.17	< 0.010	< 0.020	0.170	0.006
23/02/2015 12:40	21.8	30.0	2.4	7	102	< 0.08	< 0.010	< 0.020	< 0.080	0.007
Median	24.0	2.9	4.2	5	87	0.20	0.005	0.010	0.190	0.003
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
8/01/2015 10:45	170	120	150								
19/01/2015 9:58	53	90	100								
22/01/2015 10:19	500	400	400	26000	82	0	4	29.4	+	−	−
27/01/2015 14:43	900	110	110								
5/02/2015 9:40	6500	6600	6600	56000	15000	140	35	27.4	−	−	−
9/02/2015 13:04	60	80	80								
20/02/2015 9:25	1200	1100	1100	27000	11000	0	0	35.2	+	−	−
23/02/2015 12:40	270	40	40								
Median	385	115	130								
Guideline value (contact recreation)	280	—	—								

Tohetea Stream – Simpsons Beach

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
8/01/2015 12:25	20.4	< 0.2	4.7	7	77	0.23	0.014	0.003	0.240	0.004
19/01/2015 12:03	24.3	< 0.2	3.5	6	83	0.16	< 0.010	< 0.002	0.160	0.004
22/01/2015 12:00	19.9	< 0.2	3.8	< 3	78	0.19	< 0.010	< 0.020	0.190	0.006
27/01/2015 16:22	23.3	1.1	3.2	< 3	63	0.20	0.020	0.008	0.210	< 0.004
5/02/2015 11:41	21.2	0.9	5.2	4	80	0.26	0.024	0.007	0.270	0.004
9/02/2015 14:38	21.5	0.3	3.4	4	87	0.14	< 0.010	0.005	0.150	0.004
20/02/2015 11:53	22.4	0.2	2.3	< 3	81	0.15	< 0.010	< 0.002	0.150	< 0.004
23/02/2015 14:41	24.1	2.1	2.3	3	93	0.19	< 0.010	< 0.002	0.190	< 0.004
Median	22.0	0.3	3.5	4	81	0.19	0.005	0.004	0.190	0.004
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
8/01/2015 12:25	53	190	190								
19/01/2015 12:03	12	80	100								
22/01/2015 12:00	600	350	370	8000	1500	0	0	30.3	+	−	−
27/01/2015 16:22	700	600	600								
5/02/2015 11:41	2700	1800	2100	69000	89000	510	0	30.8	+	−	−
9/02/2015 14:38	190	350	350								
20/02/2015 11:53	110	300	310	19000	3000	0	0	31.8	−	−	−
23/02/2015 14:41	260	1000	1000								
Median	225	350	360								
Guideline value (contact recreation)	280	—	—								

Tarapatiki Stream – Whitianga

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
8/01/2015 12:43	20.1	16.1	2.2	5	80	0.09	0.014	0.011	0.100	< 0.004
19/01/2015 12:20	24.8	11.0	3.2	14	86	0.15	0.012	0.009	0.160	< 0.004
22/01/2015 12:17	19.3	15.7	4.5	9	76	0.16	< 0.010	0.021	0.180	< 0.004
27/01/2015 16:39	23.3	19.3	3.2	4	99	0.19	0.010	0.012	0.200	< 0.004
5/02/2015 12:03	21.9	6.4	6.0	8	73	0.35	0.019	0.010	0.360	0.006
9/02/2015 14:55	22.9	11.8	3.0	4	103	0.12	0.011	0.017	0.130	< 0.004
20/02/2015 12:09	23.8	11.0	4.2	6	90	0.23	< 0.010	0.042	0.280	0.005
23/02/2015 14:59	24.0	14.9	4.7	7	95	0.16	< 0.010	0.021	0.180	< 0.004
Median	23.1	13.4	3.7	7	88	0.16	0.011	0.015	0.180	0.002
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
8/01/2015 12:43	330	170	180								
19/01/2015 12:20	560	210	210								
22/01/2015 12:17	5400	1900	2000	27000	52000	280	3	29.7	+	−	−
27/01/2015 16:39	1000	410	410								
5/02/2015 12:03	4100	1500	1800	34000	32000	120	5	28.2	+	−	−
9/02/2015 14:55	480	140	160								
20/02/2015 12:09	4000	2100	2900	22000	15000	0	0	31.3	+	−	−
23/02/2015 14:59	1500	1500	1500								
Median	1250	955	955								
Guideline value (contact recreation)	280	—	—								

Taputapuatea Stream – Whitianga

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
8/01/2015 13:00	20.0	20.0	2.1	6	80	0.15	0.020	0.033	0.190	0.020
19/01/2015 12:34	26.4	18.6	2.0	5	123	0.31	< 0.010	0.010	0.320	0.026
22/01/2015 12:32	20.7	23.0	2.4	5	76	0.13	< 0.010	0.028	0.160	0.016
27/01/2015 16:52	23.2	31.0	2.8	5	96	0.12	0.108	< 0.200	< 0.300	0.022
5/02/2015 12:22	24.0	2.7	2.7	3	60	0.29	0.015	0.026	0.310	0.036
9/02/2015 15:09	22.3	0.7	2.0	< 3	81	0.17	0.013	0.019	0.190	0.012
20/02/2015 12:26	23.3	17.9	1.9	4	83	0.22	< 0.010	0.012	0.230	0.016
23/02/2015 15:32	23.3	31.0	2.3	10	91	0.20	0.017	< 0.020	0.210	0.015
Median	23.3	19.3	2.2	5	82	0.19	0.014	0.023	0.200	0.018
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
8/01/2015 13:00	670	370	550								
19/01/2015 12:34	60	40	50								
22/01/2015 12:32	2900	300	350	15000	0	0	0	31.2	−	−	−
27/01/2015 16:52	270	30	50								
5/02/2015 12:22	1500	1200	1200	44000	10000	140	0	29.3	+	−	−
9/02/2015 15:09	140	100	100								
20/02/2015 12:26	3300	500	700	18000	0	0	0	31.1	+	−	−
23/02/2015 15:32	300	50	50								
Median	485	200	225								
Guideline value (contact recreation)	280	—	—								

Purangi River – Cooks Beach

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
7/01/2015 12:10	24.5	35.0	3.5	8	110	0.24	0.240	< 0.020	0.240	0.007
12/01/2015 15:51	26.1	35.0	4.1	12	119	0.30	0.240	< 0.200	0.400	0.009
22/01/2015 11:59	20.0	34.0	3.2	10	100	0.20	0.210	< 0.200	< 0.300	0.008
27/01/2015 16:22	23.7	35.0	4.4	9	97	0.10	0.300	0.005	0.110	0.014
5/02/2015 11:46	—	35.0	4.6	14	—	0.17	0.032	< 0.020	0.170	0.012
9/02/2015 13:53	23.6	35.0	3.2	11	106	0.28	0.260	< 0.200	0.400	0.012
20/02/2015 11:32	23.9	35.0	2.5	9	98	< 0.08	0.040	< 0.020	< 0.080	0.011
23/02/2015 14:20	23.9	35.0	4.4	19	102	0.14	0.020	< 0.020	0.150	0.009
Median	23.9	35.0	3.8	11	102	0.19	0.225	0.010	0.160	0.010
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
7/01/2015 12:10	2	1	1								
12/01/2015 15:51	2	1	2								
22/01/2015 11:59	18	90	100								
27/01/2015 16:22	24	20	21								
5/02/2015 11:46	4	10	11	2400	0	0	0	31.5	+	−	−
9/02/2015 13:53	6	2	2								
20/02/2015 11:32	10	< 10	< 10								
23/02/2015 14:20	15	36	41								
Median	8	10	11								
Guideline value (contact recreation)	280	—	—								

Wigmore Stream – Hahei

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
7/01/2015 11:48	23.8	28.0	2.0	6	124	0.22	0.143	0.020	0.240	0.029
12/01/2015 14:44	25.8	30.0	1.2	6	144	0.76	0.840	0.033	0.790	0.178
22/01/2015 11:38	20.2	28.0	5.3	10	101	0.37	0.041	0.102	0.480	0.078
27/01/2015 15:18	22.5	32.0	1.7	3	106	0.25	0.230	0.110	0.360	0.074
5/02/2015 11:26	—	5.8	6.0	11	—	0.80	0.290	0.230	1.030	0.450
9/02/2015 13:32	23.6	12.5	2.9	11	213	0.73	0.115	0.640	1.370	0.760
20/02/2015 11:11	23.4	32.0	1.9	6	100	0.13	0.166	0.047	0.180	0.075
23/02/2015 13:57	23.2	32.0	2.4	13	103	0.19	0.108	0.046	0.230	0.054
Median	23.4	29.0	2.2	8	106	0.31	0.155	0.075	0.420	0.077
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
7/01/2015 11:48	29	45	58								
12/01/2015 14:44	31	30	30								
22/01/2015 11:38	1700	1000	3100	24000	17000	130	6	29.6	+	−	−
27/01/2015 15:18	160	50	60								
5/02/2015 11:26	1500	2100	2800	38000	810	0	0	32.6	+	−	−
9/02/2015 13:32	23	70	70								
20/02/2015 11:11	120	200	250								
23/02/2015 13:57	160	170	260								
Median	140	120	160								
Guideline value (contact recreation)	280	—	—								

Taiwawe Stream – Hot Water Beach

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
7/01/2015 11:21	21.1	4.4	3.8	7	105	0.29	0.021	0.097	0.390	< 0.004
12/01/2015 14:19	28.5	6.3	2.9	6	109	0.26	0.033	0.044	0.300	< 0.004
22/01/2015 11:15	20.5	3.7	2.2	4	90	0.17	< 0.010	0.005	0.180	< 0.004
27/01/2015 14:50	24.2	9.9	2.8	4	107	0.21	< 0.010	0.010	0.220	< 0.004
5/02/2015 11:05	—	1.4	3.9	4	—	0.28	< 0.010	< 0.020	0.280	< 0.004
9/02/2015 13:12	23.6	5.4	3.4	10	150	0.19	0.015	0.037	0.230	< 0.004
20/02/2015 10:46	29.6	3.2	2.2	< 3	173	0.17	< 0.010	< 0.020	0.170	< 0.004
23/02/2015 13:38	27.4	8.1	1.8	5	119	0.18	< 0.010	< 0.020	0.190	< 0.004
Median	24.2	4.9	2.9	5	109	0.20	0.005	0.010	0.225	0.002
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
7/01/2015 11:21	90	170	190								
12/01/2015 14:19	13	10	20								
22/01/2015 11:15	49	160	180								
27/01/2015 14:50	130	150	150								
5/02/2015 11:05	320	400	460	21000	3900	200	1	31.5	+	−	−
9/02/2015 13:12	110	360	360								
20/02/2015 10:46	210	120	120								
23/02/2015 13:38	360	1700	1800								
Median	120	165	185								
Guideline value (contact recreation)	280	—	—								

Grahams Creek – Tairua

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
7/01/2015 10:45	23.8	17.9	3.7	9	113	0.12	0.014	< 0.020	0.130	< 0.004
12/01/2015 13:41	27.8	19.8	2.4	7	140	0.10	< 0.010	< 0.200	< 0.300	< 0.004
22/01/2015 10:29	19.0	29.0	1.8	10	93	0.11	0.109	< 0.200	< 0.300	< 0.004
27/01/2015 14:13	23.0	33.0	2.3	4	110	0.13	0.179	< 0.200	< 0.300	0.004
5/02/2015 10:32	—	11.1	2.8	5	—	0.11	< 0.010	< 0.020	0.110	< 0.004
9/02/2015 12:40	21.5	22.0	1.8	4	107	0.08	0.011	< 0.200	< 0.300	< 0.004
20/02/2015 10:11	21.1	30.0	2.2	8	82	< 0.05	< 0.020	< 0.020	< 0.060	< 0.004
23/02/2015 13:01	22.3	30.0	2.7	7	96	0.13	0.034	< 0.020	0.140	0.004
Median	22.3	25.5	2.4	7	107	0.11	0.013	0.055	0.145	0.002
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
7/01/2015 10:45	150	100	110								
12/01/2015 13:41	45	40	40								
22/01/2015 10:29	420	600	600	7100	22000	120	0	29.8	+	−	−
27/01/2015 14:13	80	43	51								
5/02/2015 10:32	900	300	300	33000	180000	730	12	26.8	+	−	+
9/02/2015 12:40	370	96	120								
20/02/2015 10:11	500	220	270	2900	320	0	0	31	+	−	−
23/02/2015 13:01	490	170	210								
Median	395	135	165								
Guideline value (contact recreation)	280	—	—								

Pepe Stream – Tairua

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
7/01/2015 10:25	21.3	35.0	4.9	13	115	0.31	0.200	< 0.020	0.310	0.006
12/01/2015 13:27	25.7	35.0	2.2	15	121	0.22	0.210	< 0.200	0.300	0.005
22/01/2015 10:23	18.8	35.0	9.3	16	105	0.22	0.220	< 0.200	0.300	0.008
27/01/2015 13:37	22.6	35.0	1.4	5	109	0.12	0.210	< 0.200	< 0.300	0.006
5/02/2015 10:20	—	34.0	2.2	8	—	0.08	< 0.010	< 0.020	0.080	0.006
9/02/2015 12:29	22.0	35.0	0.5	4	127	0.16	0.163	< 0.200	< 0.300	0.004
20/02/2015 9:57	21.5	35.0	1.1	5	96	< 0.08	< 0.020	< 0.020	< 0.08	0.005
23/02/2015 12:51	21.6	35.0	3.4	6	107	0.29	0.260	< 0.020	0.300	0.009
Median	21.6	35.0	2.2	7	109	0.19	0.205	0.055	0.225	0.006
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
7/01/2015 10:25	34	10	10								
12/01/2015 13:27	4	13	23								
22/01/2015 10:23	5600	2000	2400	5100	210	0	0	29.8	+	−	−
27/01/2015 13:37	38	6	7								
5/02/2015 10:20	1100	160	230	2000	2200	0	0	32.2	+	−	+
9/02/2015 12:29	2	1	1								
20/02/2015 9:57	50	5	20								
23/02/2015 12:51	340	300	540								
Median	44	11.5	21.5								
Guideline value (contact recreation)	280	—	—								

Otahu River – Whangamata

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
7/01/2015 9:35	21.0	35.0	0.9	3	108	0.23	0.240	< 0.020	0.230	0.004
12/01/2015 12:33	23.8	35.0	1.7	13	110	0.25	0.210	< 0.200	0.300	0.005
22/01/2015 9:22	19.6	34.0	1.1	4	107	0.16	0.230	< 0.200	< 0.300	0.008
27/01/2015 12:45	21.8	35.0	3.0	10	101	0.24	0.250	< 0.200	0.300	0.008
5/02/2015 9:32	—	35.0	0.9	6	—	< 0.05	< 0.010	< 0.020	< 0.060	0.006
9/02/2015 11:27	21.5	35.0	0.5	< 3	110	0.17	0.210	< 0.200	< 0.300	0.006
20/02/2015 9:02	21.9	35.0	0.8	< 3	99	0.26	0.240	< 0.020	0.270	0.006
23/02/2015 12:00	21.9	35.0	1.2	< 3	103	< 0.08	< 0.02	< 0.020	< 0.080	0.008
Median	21.8	35.0	1.0	4	107	0.20	0.220	0.055	0.190	0.006
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
7/01/2015 9:35	4	3	3								
12/01/2015 12:33	3	2	2								
22/01/2015 9:22	3	8	8								
27/01/2015 12:45	34	1	2								
5/02/2015 9:32	1200	27	28	7700	0	0	3	32.9	+	−	−
9/02/2015 11:27	20	23	23								
20/02/2015 9:02	10	< 10	< 10								
23/02/2015 12:00	9	6	7								
Median	9.5	6	7								
Guideline value (contact recreation)	280	—	—								

Te Ramarama Stream – Whiritoa

Physical and chemical parameters

Sample date/time	Temperature (°C)	Salinity (ppt)	Turbidity (NTU)	Total suspended solids (g/m^3)	Oxygen saturation (%)	Total Kjeldahl nitrogen (TKN) (g/m^3)	Total ammoniacal-N (g/m^3)	Nitrate-N + nitrite-N (g/m^3)	Total nitrogen (g/m^3)	Dissolved reactive phosphorus (g/m^3)
7/01/2015 9:07	20.9	7.3	2.3	< 3	96	0.23	0.050	0.043	0.280	< 0.004
12/01/2015 12:02	23.6	6.3	1.8	4	103	0.18	< 0.010	0.007	0.190	< 0.004
22/01/2015 8:54	27.6	35.0	2.0	7	105	0.19	0.178	< 0.200	< 0.300	0.006
27/01/2015 12:10	23.9	17.9	3.3	23	108	0.39	0.014	< 0.200	0.400	< 0.004
5/02/2015 9:02	—	5.0	1.3	6	—	0.38	< 0.010	0.049	0.420	< 0.004
9/02/2015 10:53	21.3	24.0	1.4	< 3	108	0.10	0.022	0.034	0.130	0.008
20/02/2015 8:33	21.3	5.8	4.2	32	97	0.15	< 0.010	< 0.020	0.170	< 0.004
23/02/2015 11:07	22.5	7.9	1.6	3	113	0.24	< 0.010	0.004	0.240	< 0.004
Median	22.5	7.6	1.9	5	105	0.21	0.010	0.039	0.215	0.002
Guideline value	—	—	<10.0	—	>80	—	<0.015	<0.015	<0.300	<0.005

Faecal indicator bacteria

	Culture based tests			Microbial source tracking							
Sample date/time	**Enterococci** (cfu/100 mL)	***E. coli*** (cfu/100 mL)	**Faecal coliforms** (cfu/100 mL)	**General bacteroides** (counts)	**Ruminant bacteroides** (counts)	**Cow bacteroides** (counts)	**Human bacteroides** (counts)	**Possum** (C_t)	**Gull** (+/−)	**Dog** (+/−)	**Pig** (+/−)
7/01/2015 9:07	230	420	570								
12/01/2015 12:02	39	200	340								
22/01/2015 8:54	54	40	40								
27/01/2015 12:10	170	100	130								
5/02/2015 9:02	3500	2400	2800	35000	29000	240	1	Not detected	+	−	−
9/02/2015 10:53	33	170	260								
20/02/2015 8:33	2100	700	1100	17000	2800	0	0	38.3	+	−	−
23/02/2015 11:07	120	510	510								
Median	145	310	425								
Guideline value (contact recreation)	280	—	—								

Appendix D – Maps of ecological health parameter results

Turbidity

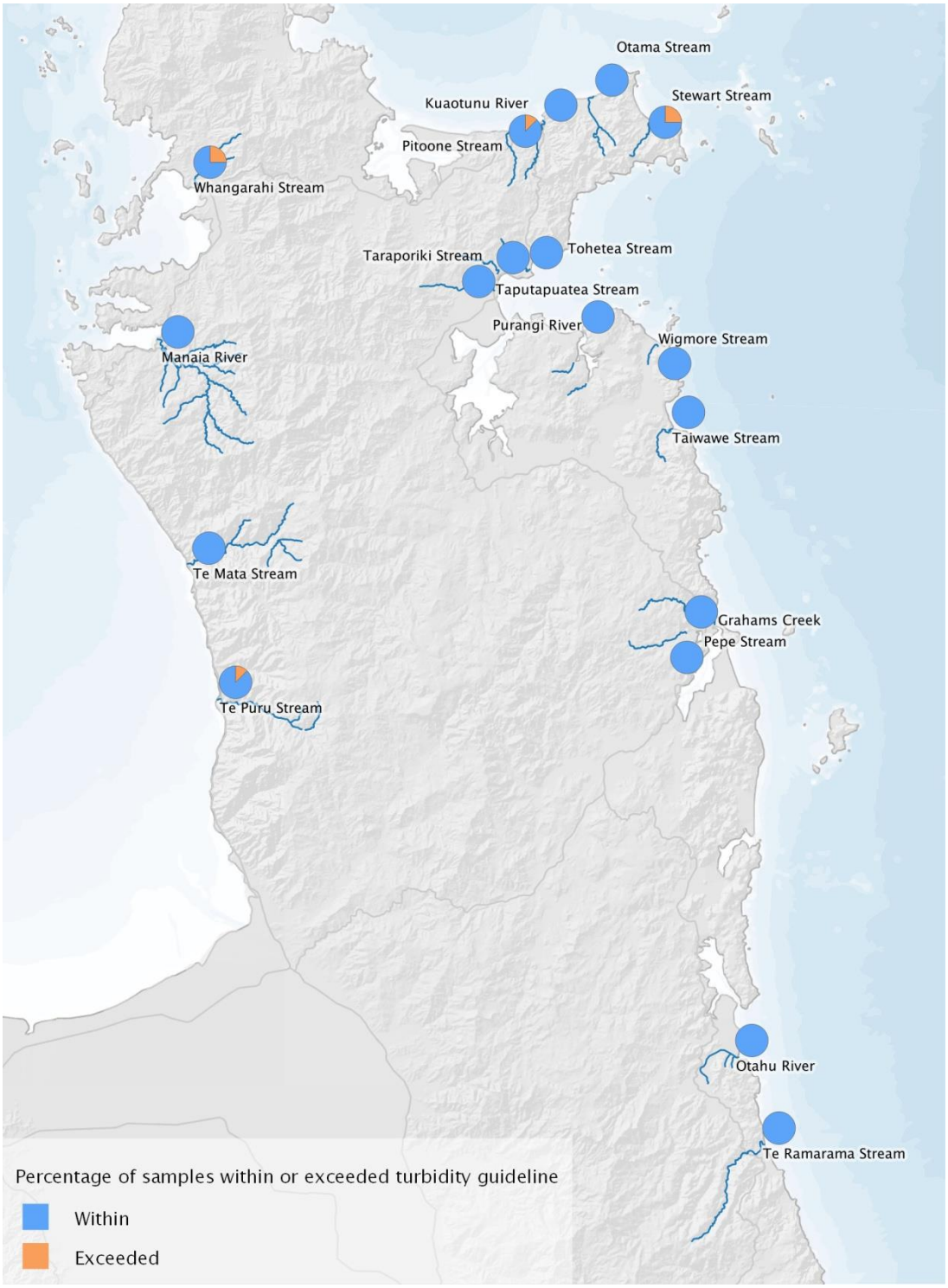


Figure D1: **Percent of water samples from each stream mouth that were within or exceeded the ANZECC (2000) water quality guideline for turbidity in estuarine water.**

Dissolved oxygen

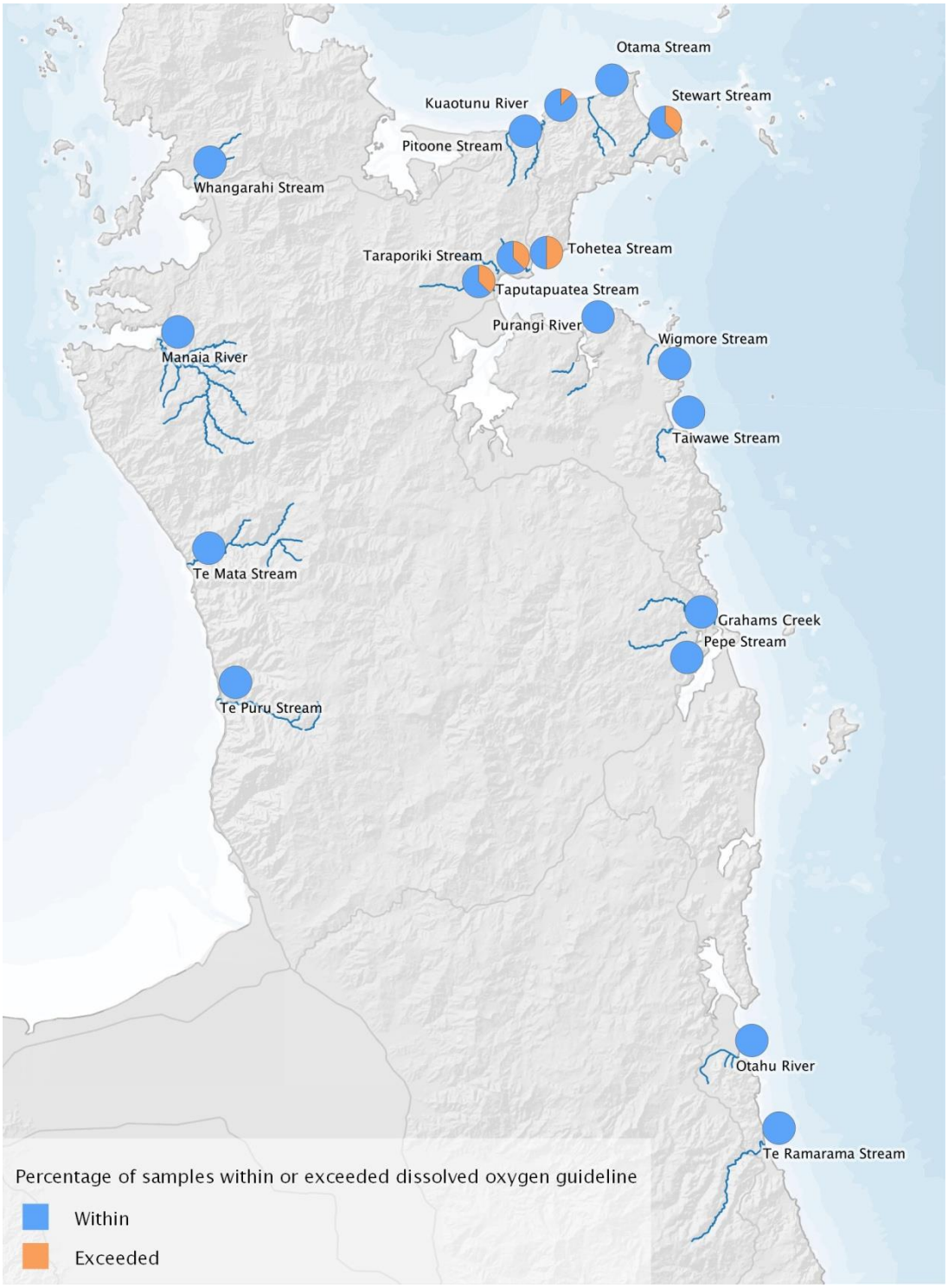


Figure D2: **Percent of water samples from each stream mouth that were within or exceeded the ANZECC (2000) water quality guideline for dissolved oxygen in estuarine water.**

Total nitrogen

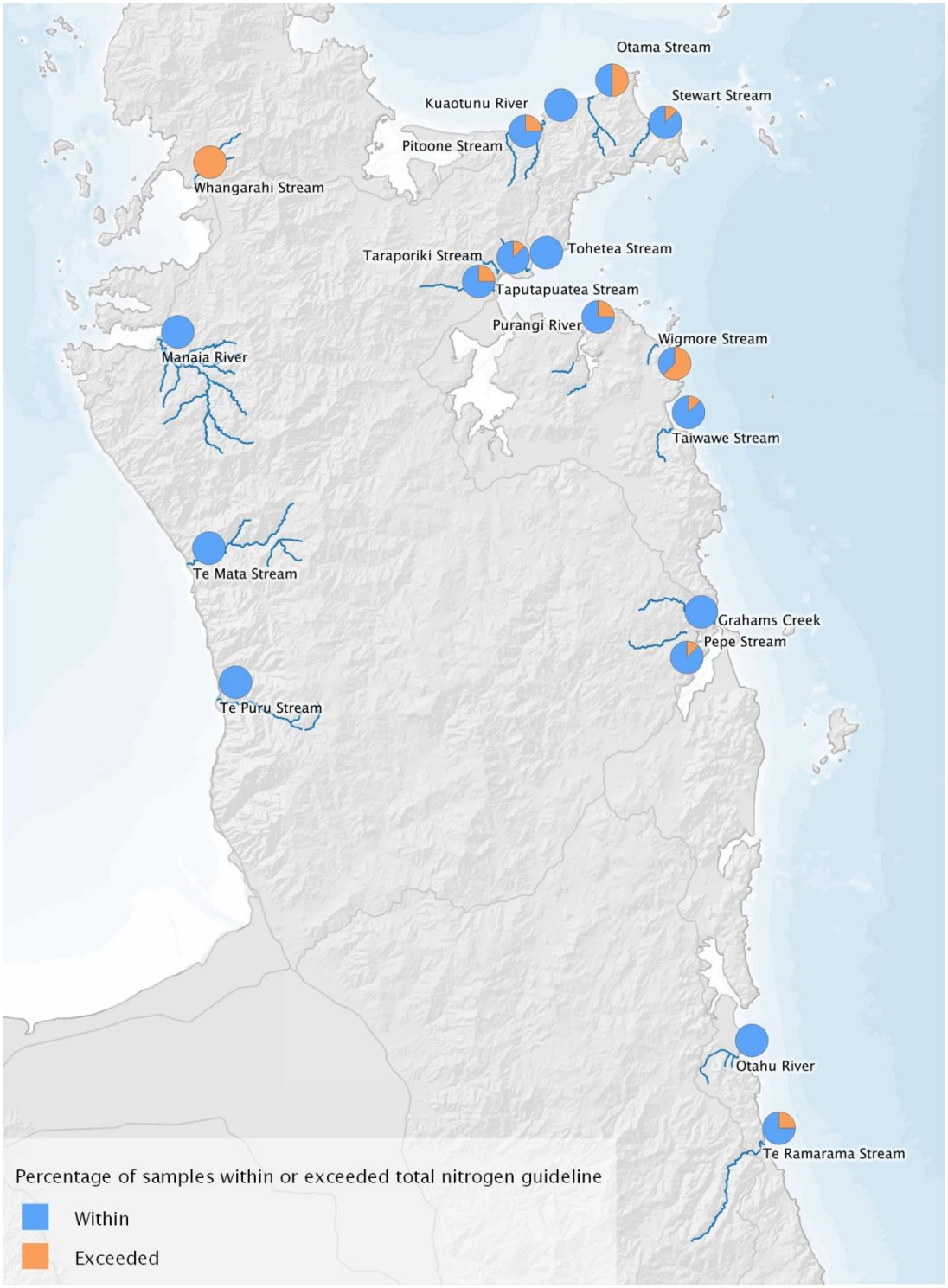


Figure D3: **Percent of water samples from each stream mouth that were within or exceeded the ANZECC (2000) water quality guideline for total nitrogen in estuarine water.**

Nitrate and nitrite nitrogen

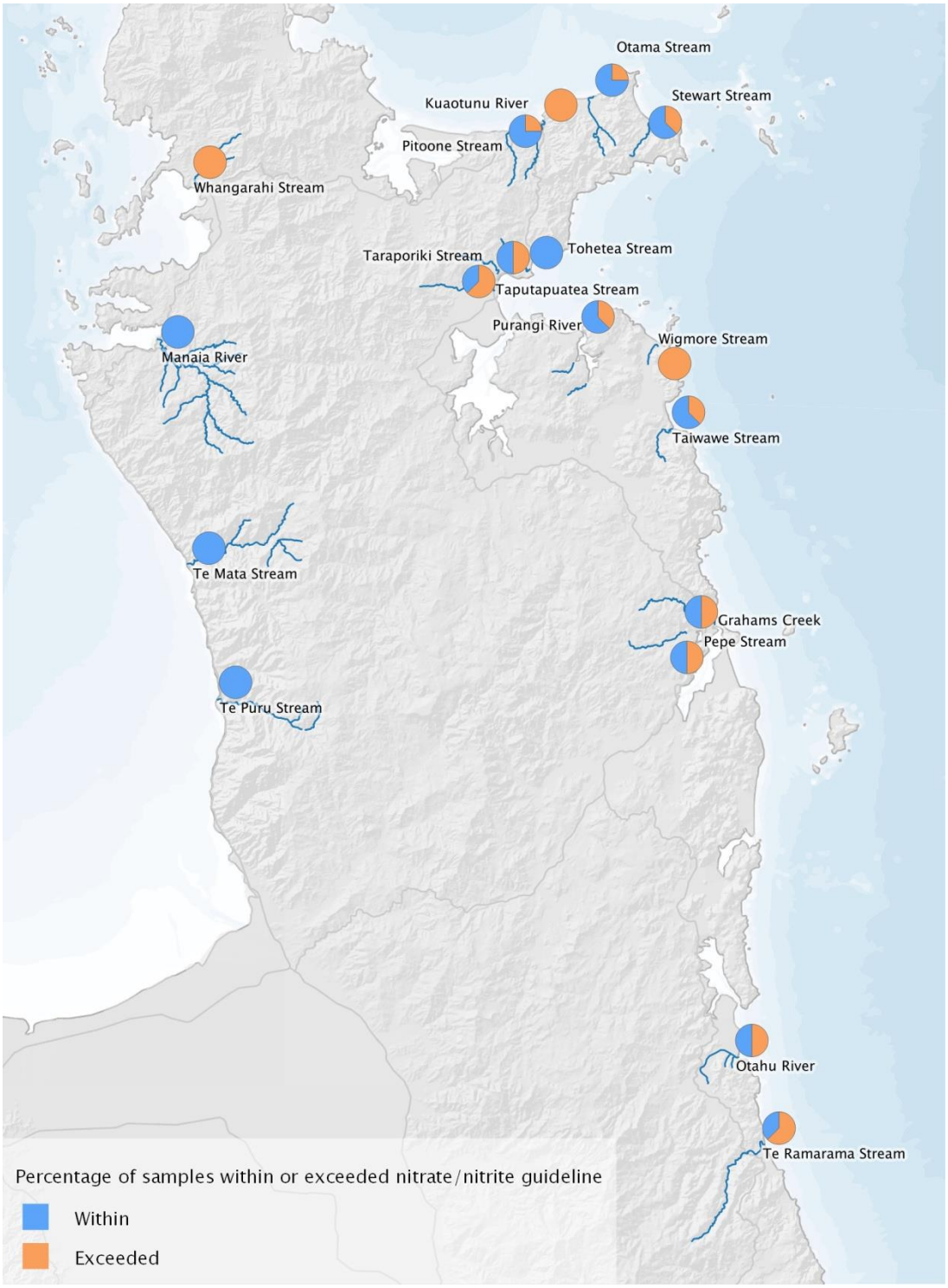


Figure D4: **Percent of water samples from each stream mouth that were within or exceeded the ANZECC (2000) water quality guideline for nitrate and nitrite nitrogen in estuarine water.**

Ammoniacal nitrogen

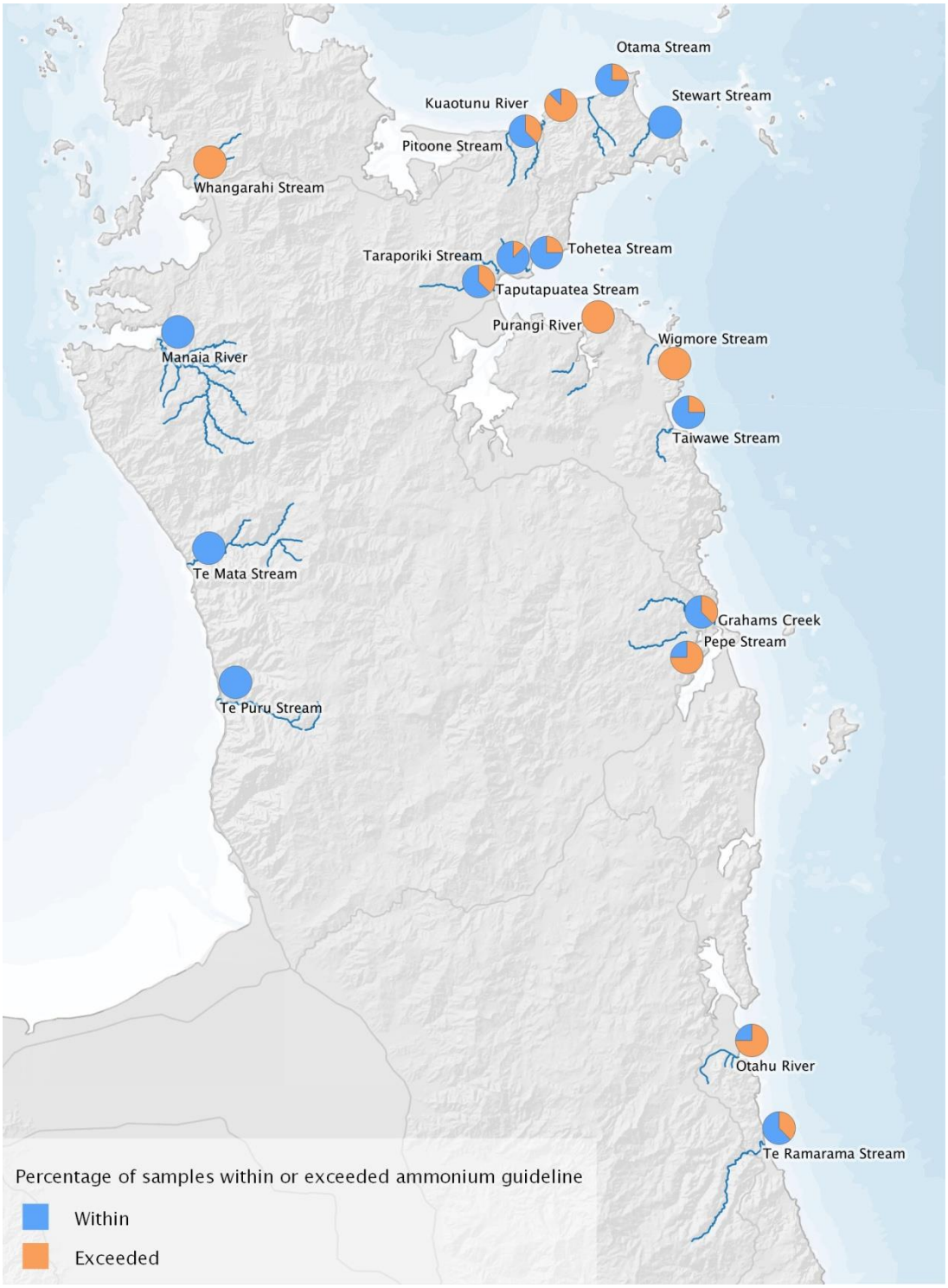


Figure D5: **Percent of water samples from each stream mouth that were within or exceeded the ANZECC (2000) water quality guideline for ammoniacal nitrogen in estuarine water.**

Dissolved reactive phosphorus

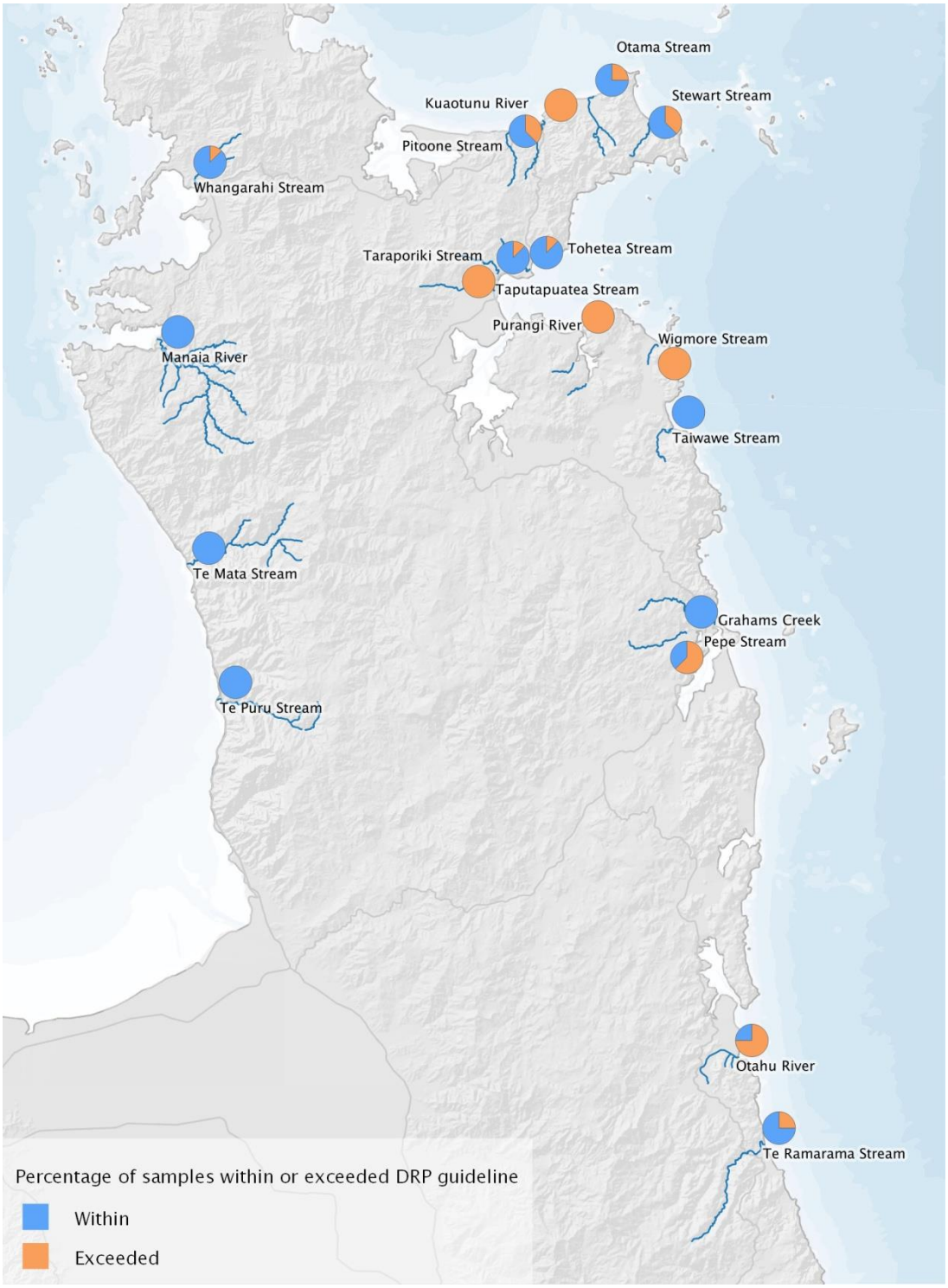
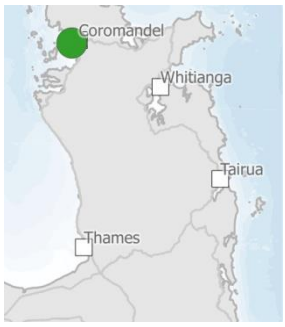


Figure D6: **Percent of water samples from each stream mouth that were within or exceeded the ANZECC (2000) water quality guideline for dissolved reactive phosphorus in estuarine water.**

Appendix E – Individual site summaries

Whangarahi Stream mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)



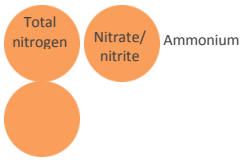
This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity was within the guideline value on six out of eight sampling occasions. This indicates that the water clarity at this location was high most of the time. At sites like this, some common causes of increased turbidity are particles being washed from the land into the stream following heavy rainfall, and from particles that are resuspended when the stream is flowing quickly.
Dissolved oxygen 	Dissolved oxygen was always within the guideline value. This indicates that there was sufficient oxygen in the water at the time of sampling for the organisms that live there.
Nitrogen 	Nitrogen concentrations consistently exceeded guideline values at this location. The three measured nitrogen parameters were usually more than 10 times greater than the guideline value and, on occasion, over 100 times greater. The reason for such high exceedances is not clear from this study, so further investigation of this site is required to determine the cause and whether there are any ecologically significant effects.
Phosphorus (dissolved reactive) 	Phosphorus concentrations were within the guideline value on seven out of eight sampling occasions. The one exceedance was relatively minor and was detected following heavy rainfall.

FAECAL BACTERIA

Enterococci 	Enterococci levels were below the guideline value on seven out of eight sampling occasions.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health New Zealand.

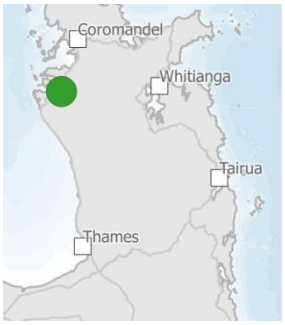
	The one exceedance occurred after heavy rainfall, where contaminants are washed from the area surrounding the stream and flushed out to sea via the stream mouth. It is recommended to avoid swimming at these types of locations 24–48 hours following heavy rainfall.
Potential faecal sources detected	Ruminant animals (not cows), humans, possums, and gulls.

SUMMARY

During the two sampling months, water quality at this site was typically within guideline values. Exceedances were seen following heavy rainfall, which is typical in these water types. The consistently high concentrations of nitrogen are not typical, however, and further investigation is needed to identify the cause and any potential ecological significance.

Manaia River mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)



This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity levels were within guideline values on each sampling occasion. This indicates high water clarity at these times.
Dissolved oxygen 	Dissolved oxygen was always within the guideline value at the time of sampling. This indicates that there was sufficient oxygen for the organisms that live there.
Nitrogen 	Nitrogen concentrations were within guideline values on each sampling occasion. The levels of nitrogen on these occasions are unlikely to promote nuisance algal growth.
Phosphorus (dissolved reactive) 	Phosphorus concentrations were within the guideline value on each of the sampling occasions. The levels of phosphorus on these occasions are unlikely to promote nuisance algal growth.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

FAECAL BACTERIA

Enterococci 	Enterococci levels were below the guideline value on six out of eight sampling occasions. One exceedance occurred after heavy rainfall, where contaminants are washed from the area surrounding the stream and flushed out to sea via the stream mouth. It is recommended to avoid swimming at these types of locations 24–48 hours following heavy rainfall. The cause of the other exceedance is unknown and was 20% higher than the guideline value.
Potential faecal sources detected	Ruminant animals (not cows), humans, possums, and pigs.

SUMMARY

During the two sampling months, the ecological health of this site was very high. Faecal bacteria exceeded guideline values on two occasions. On one of these occasions, this exceedance followed heavy rainfall, which is typical in these water types.

Te Mata Stream mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)

This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity was within the guideline value on each sampling occasion. This indicates high water clarity at these times.
Dissolved oxygen 	Dissolved oxygen was within the guideline value on each sampling occasion. This indicates that there was sufficient oxygen for the organisms that live there.
Nitrogen 	Nitrogen concentrations were within guideline values on each sampling occasion. The levels of nitrogen on these occasions are unlikely to promote nuisance algal growth.
Phosphorus (dissolved reactive) 	Phosphorus concentrations were within the guideline value on each of the sampling occasions. The levels of phosphorus on these occasions are unlikely to promote nuisance algal growth.

FAECAL BACTERIA

Enterococci 	Enterococci levels were below the guideline value on seven out of eight sampling occasions. The one exceedance occurred after heavy rainfall, where contaminants are washed from the area surrounding the stream and flushed out to sea via the stream mouth. It is recommended to avoid swimming at these types of locations 24–48 hours following heavy rainfall.
Potential faecal sources detected	Ruminant animals (not cows), humans, possums, and pigs.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

SUMMARY

During the two sampling months, the ecological health of this site was very high. Faecal bacteria exceeded the guideline value on one occasion following heavy rainfall, which is typical in these water types.

Te Puru Stream mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)

This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity was within the guideline value on seven out of eight sampling occasions. This indicates that the water clarity at this location was high most of the time.
Dissolved oxygen 	Dissolved oxygen was within the guideline value on each sampling occasion. This indicates that there was sufficient oxygen for the organisms that live there.
Nitrogen 	Nitrogen concentrations were within guideline values on each sampling occasion. The levels of nitrogen on these occasions are unlikely to promote nuisance algal growth.
Phosphorus (dissolved reactive) 	Phosphorus concentrations were within the guideline value on each of the sampling occasions. The levels of phosphorus on these occasions are unlikely to promote nuisance algal growth.

FAECAL BACTERIA

Enterococci 	Enterococci levels were below the guideline value on seven out of eight sampling occasions. The one exceeded did not coincide with a heavy rainfall or high spring tide event and there is not enough supplementary information to determine the cause. The enterococci concentration was almost three times higher than the guideline value indicating an elevated health risk on this one occasion.
Potential faecal sources detected	Ruminant animals (not cows) and possums.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

SUMMARY

During the two sampling months, the ecological health of this site was very high. Faecal bacteria exceeded the guideline value on one occasion following heavy rainfall, which is typical in these water types, and it is recommended to avoid swimming at these locations 24–48 hours following heavy rainfall.

Pitoone Stream mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)

This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity was within the guideline value on seven out of eight sampling occasions. The one exceedance occurred following a heavy rainfall event. This indicates high water clarity most of the time during the sampling period.
Dissolved oxygen 	Dissolved oxygen was always within the guideline value. This indicates that there was sufficient oxygen for the organisms that live there.
Nitrogen 	Nitrogen concentrations were within guideline values on about three-quarters of the sampling occasions. The exceedances were measured following high tides or heavy rainfall, when contaminants are washed from the surrounding land into the water. Excess nitrogen in the water can cause nuisance weeds and algae to grow. Common sources include raw and treated sewage, industrial discharges, and runoff or soil leachate from pastures, crops, and lawns that have been fertilised.
Phosphorus (dissolved reactive) 	Phosphorus concentrations were within the guideline value on five out of seven sampling occasions. Two of the exceedances were minor and followed a spring tide or heavy rainfall. The reason for one exceedance, which was over twice the guideline, is not clear from this study. Common sources of excess phosphorus include runoff from pastures, crops, and lawns that have been fertilised.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

FAECAL BACTERIA

Enterococci 	Enterococci concentrations were within guideline values on five out of eight sampling occasions. The two exceedances followed a heavy rainfall and a high spring tide and had levels that were about ten times greater than the guideline value. This indicates an elevated health risk at these times. It is recommended to avoid swimming at these types of locations 24–48 hours following heavy rainfall. The third exceedance did not follow heavy rainfall or high spring tides. One this occasion, the reason is unclear from the information gathered during this sampling period.
Potential faecal sources detected	Ruminant animals, humans, possums, and gulls.

SUMMARY

During the two sampling months, the water quality of this site was typically good. Elevated levels of contaminants (nutrients and faecal bacteria), however, were seen following heavy rainfall and high tides, which is typical for these types of water bodies.

Kuaotunu Stream mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)

This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page[1].

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity levels were within the guideline value on every sampling occasion. This indicates high water clarity at these times.
Dissolved oxygen 	Dissolved oxygen was within the guideline value on seven out of eight sampling occasions. The reason for the one exceedance is unclear; however, it appears that there is sufficient dissolved oxygen at this location for the organisms that live there.
Nitrogen 	Total nitrogen concentrations were within the guideline value on every sampling occasion, however, nitrate/nitrite and ammonium concentrations exceeded guideline values on most sampling occasions. This indicates that the source of nitrogen is likely a result of the catchment land use and the resulting nutrients that are washed into the stream at the time of sampling. Common sources include raw and treated sewage, industrial discharges, and runoff or soil leachate from pastures, crops, and lawns that have been fertilised. Elevated levels of nitrogen may contribute to nuisance weed and algae growth.
Phosphorus (dissolved reactive) 	Phosphorus concentrations exceeded the guideline value on every sampling occasion. Excess phosphorus may lead to nuisance weed and algal growth. Common sources of excess phosphorus include runoff from pastures, crops, and lawns that have been fertilised.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

FAECAL BACTERIA

Enterococci 	Enterococci concentrations were within the guideline value on three out of eight sampling occasions. Some of the exceedances were particularly high, ranging from 3–20 times higher than the guideline value, which indicates an elevated risk while swimming at those times. Most exceedances occurred following a heavy rainfall event or high tide, which is typical for these types of locations.
Potential faecal sources detected	Ruminant animals (including cows), humans, possums, gulls, and pigs.

SUMMARY

During the two sampling months, the water clarity and dissolved oxygen at this location were typically high. This location frequently exceeded nutrient guideline values, which may promote nuisance weed and algal growth. Faecal bacteria also frequently exceeded guideline values, which may indicate an elevated risk when using the water recreationally (e.g., swimming).

Otama Stream mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)

This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames–Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity levels were within guideline values on each sampling occasion. This indicates high water clarity at these times.
Dissolved oxygen 	Dissolved oxygen was always within the guideline value. This indicates that there was sufficient oxygen in the water at the time of sampling for the aquatic species that live there.
Nitrogen 	Nitrogen concentrations were within the guideline values on at least half of the sampling occasions. On four occasions, total nitrogen concentrations were about 30% higher than the guideline value. Nitrate/nitrite and ammonium concentrations exceeded the guideline values only on three occasions, but the exceedances ranged from 7–16 times greater than the guideline value. The reason for the exceedances is unclear from the information gathered during this sampling period. Excess nitrogen in the water can contribute to 'nuisance' algal growth under certain conditions.
Phosphorus (dissolved reactive) 	Phosphorus concentrations were within the guideline value on six of eight sampling occasions. The two exceedances were about 20% greater than the guideline value. Common sources of excess phosphorus include runoff from pastures, crops, and lawns that have been fertilised.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

FAECAL BACTERIA

Enterococci 	Enterococci concentrations were within the guideline value on five out of eight sampling occasions. The greatest exceedance (about 18 times greater than the guideline values) was measured following heavy rainfall. This indicates an elevated health risk at the time of sampling. It is recommended to avoid swimming at these types of locations 24–48 hours following heavy rainfall. The other exceedances were relatively small in comparison to the other one and did not follow heavy rainfall. One exceedance coincided with high spring tides but the reason for the third exceedance is unclear from the information gathered during this sampling period.
Potential faecal sources detected	Ruminant animals (including cows), humans, possums, gulls, and pigs.

SUMMARY

During the two sampling months, the water quality at Otama Stream mouth was typically good and suitable for the aquatic species that may live there. Occasionally, nutrient concentrations exceeded the guideline value but the reason for this is unclear from the information gathered during this sampling period. Faecal bacteria were elevated following heavy rainfall or high tides. It is recommended to avoid swimming following these events in these types of waters.

Stewart Stream mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)

This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity levels were below the guideline value on six out of eight sampling occasions. This indicates that usually water clarity levels are high but can decrease slightly on occasion following heavy rainfall.
Dissolved oxygen 	Dissolved oxygen was within the guideline value on five out of eight sampling occasions. This indicates that the water is usually well oxygenated, which is important for the animals that need it to breathe. At times, the dissolved oxygen concentration decreased to levels that may be unsuitable for some aquatic species that live there. Common causes of oxygen reduction in the water are wastewater discharges, plant (including algae) growth and respiration, and urban runoff, but may also be related to warmer temperatures and low flow.
Nitrogen 	Nitrogen concentrations were typically within guideline values at the time of sampling. The guidelines were exceeded following heavy rainfall, which washes nutrients that are dissolved or bound to sediment particles into the water.
Phosphorus (dissolved reactive) 	Phosphorus concentrations were within the guideline value on five out of seven sampling occasions. The three exceedances were relatively minor and followed high tides and heavy rainfall.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

FAECAL BACTERIA

Enterococci 	The enterococci concentration was within guideline values on four out of eight sampling indications. This indicates an elevated risk of swimming at this location about half the time. The greatest exceedance followed heavy rainfall and was over 20 times the guideline value. It is recommended to avoid swimming at these types of locations 24–48 hours following heavy rainfall.
Potential faecal sources detected	Ruminant animals (including cows), humans, possums, and gulls.

SUMMARY

During the two sampling months, nutrient concentrations were usually within the guideline value and any exceedances were relatively minor. Occasionally, dissolved oxygen decreased to concentrations that may be unfavourable for the aquatic species the live there and need it to breathe; the cause for these decreases are unknown from this study.

Faecal bacteria were only within guideline values half of the time during the sampling period. Following heavy rainfall in the area, the enterococci concentration was more than 20 times the guideline value, which indicates an elevated risk when using the water recreationally (e.g., swimming). The other exceedances, although still above the guideline value, were much smaller than this.

Tohetea Stream mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)

This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity levels were within guideline values on each sampling occasion. This indicates high water clarity at these times.
Dissolved oxygen 	Dissolved oxygen was within the guideline value on four out of eight sampling occasions. Three of these were only just outside the guideline range. This indicates that there may be some high oxygen-consuming processes occurring in these waters. Common causes of oxygen reduction in the water are wastewater discharges, plant (including algae) growth and respiration, and urban runoff, but may also be related to high temperatures and low flow.
Nitrogen 	Nitrogen concentrations were typically within the guideline values. On two sampling occasions, ammoniacal nitrogen exceeded the guideline value. This exceedance was less than double the guideline value, so unlikely to promote nuisance weed or algal growth since other nitrogen concentrations were low.
Phosphorus (dissolved reactive) 	Phosphorus concentrations were within the guideline value on seven out of eight sampling occasions. The one exceedance was relatively minor and was detected following heavy rainfall.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

FAECAL BACTERIA

Enterococci 	Enterococci concentrations were within the guideline value on five out of eight sampling occasions. The exceedances were around high spring tides and following heavy rainfall. After heavy rainfall, the enterococci concentration was particularly high at about 10 times the guideline value, which indicates an elevated risk when using this water recreationally (e.g., swimming). This is common in these types of water.
Potential faecal sources detected	Ruminant animals (including cows), possums, and gulls.

SUMMARY

During the two sampling months, the ecological health was typically high. Following heavy rainfall, faecal bacteria were particularly high. It is recommended to avoid swimming at these locations 24–48 hours following heavy rainfall.

Tarapatiki Stream mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)

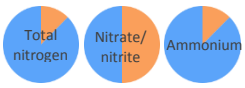
This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity levels were within guideline values on each sampling occasion. This indicates high water clarity at these times.
Dissolved oxygen 	Dissolved oxygen was within the guideline value on five out of eight sampling occasions. This indicates that the water is usually well oxygenated, which is important for the animals that need it to breathe, but at times, can decrease. Common causes of oxygen reduction in the water are wastewater discharges, plant (including algae) growth and respiration, and urban runoff, but may also be linked to warmer water temperatures and low flow.
Nitrogen 	Nitrogen concentrations were usually within guideline values. Nitrate/nitrite exceeded the guideline value half of the time; often, the exceedance was only just outside the guideline value. Exceedances of total nitrogen and ammonium were measured following heavy rainfall, as contaminants are washed from the surrounding land into the stream mouth.
Phosphorus (dissolved reactive) 	Phosphorus concentrations were within the guideline value on seven out of eight sampling occasions. The one exceedance was relatively minor and was detected following heavy rainfall.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

FAECAL BACTERIA

Enterococci 	All water samples exceeded the guideline value. This indicates an elevated risk when using this water recreationally (e.g., swimming) at the time of sampling. Exceedances ranged from close to the guideline up to 20 times greater than the guideline. The greatest exceedances coincided with spring tides and following heavy rainfall.
Potential faecal sources detected	Ruminant animals (including cows), possums, gulls, and humans.

SUMMARY

During the two sampling months, the ecological health of the stream mouth was typically good. Some elevated nutrients were washed into the stream following heavy rainfall, which is typical for these types of waters.

Faecal bacteria consistently exceeded guidelines at this location and were particularly high around spring tides and following heavy rainfall. It is recommended to avoid swimming at these types of locations 24–48 hours following heavy rainfall.

Taputapuatea Stream mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)

This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity levels were within guideline values on each sampling occasion. This indicates high water clarity at these times.
Dissolved oxygen 	Dissolved oxygen was within the guideline value on five out of eight sampling occasions. This indicates that the water is usually well oxygenated, which is important for the animals that need it to breathe, but at times, can decrease. Common causes of oxygen reduction in the water are wastewater discharges, plant (including algae) growth and respiration, and urban runoff, but may also be related to warmer water temperatures and low flow.
Nitrogen 	Nitrogen concentrations were within guideline values between four to six sampling occasions. On the occasion when nitrate/nitrite and ammoniacal nitrogen concentrations were the greatest, there were no spring tides or heavy rainfall. This indicates some other cause of contamination that cannot be identified by this study. Excess nitrogen in the water can contribute to 'nuisance' algal growth under certain conditions.
Phosphorus (dissolved reactive) 	Phosphorus concentrations exceeded the guideline value on every sampling occasion. The exceedance was usually around four times greater than the guideline value. Excess phosphorus may lead to nuisance weed and algal growth. Common sources of excess phosphorus include runoff from pastures, crops, and lawns that have been fertilised.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

FAECAL BACTERIA

Enterococci 	Enterococci concentrations were within guideline values on three out of eight sampling occasions. This indicates that sometimes during the sampling period, there was an elevated risk of swimming at this location. The greatest exceedances (about 10 times the guideline value) occurred during spring tides. Usually, the greatest exceedances at this type of water body occurs following heavy rainfall.
Potential faecal sources detected	Ruminant animals (including cows), possums, and gulls.

SUMMARY

The water quality at this location was variable during the two months of sampling. The greatest concentration of contaminants (nutrients and faecal bacteria) occurred during spring tides, rather than following heavy rainfall, which is in contrast to many other locations in this study. The combination of warm water temperatures, low flow, and elevated nutrients may promote the growth of weeds and nuisance algae.

Purangi River mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)

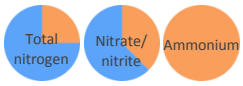
This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity levels were within the guideline value on every sampling occasion. This indicates high water clarity at these times.
Dissolved oxygen 	Dissolved oxygen was within the guideline value on each sampling occasion. This indicates that there was sufficient oxygen for the organisms that live there.
Nitrogen 	Total nitrogen and nitrate/nitrite concentrations were usually within their respective guideline values. Ammoniacal nitrogen was particularly high at this site with exceedances up to 20 times the guideline value. There were no clear patterns between nitrogen exceedances and high tides or heavy rainfall as was seen at other sites during this sampling period.
Phosphorus (dissolved reactive) 	Phosphorus concentrations were about two times greater than the guideline value on every sampling occasion. Excess phosphorus may lead to nuisance weed and algal growth. Common sources of excess phosphorus include runoff from pastures, crops, and lawns that have been fertilised.

FAECAL BACTERIA

Enterococci 	Enterococci levels were below the guideline value on each sampling occasion. This indicates that the water was suitable for contact recreation (e.g., swimming) at the time of sampling.
Potential faecal sources detected	Possums and gulls.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

SUMMARY

Water clarity, faecal bacteria, and dissolved oxygen were always within guideline values at this site. This indicates that the water has good clarity and low faecal contamination, which means that the water was suitable for recreational use (e.g., swimming).

This locations was, however, susceptible to frequent exceedances of nutrient guidelines, particularly ammoniacal nitrogen and phosphorus. The source of these exceedances are not clear from this study. Excess nutrients may make the location more prone to the growth of weeds and nuisance algae.

Wigmore Stream mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)

This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity levels were within guideline values on each sampling occasion. This indicates high water clarity at these times.
Dissolved oxygen 	Dissolved oxygen was always within the guideline value. This indicates that there was sufficient oxygen in the water at the time of sampling for the organisms that live there.
Nitrogen 	Nutrient concentrations usually exceeded guideline values during the sampling period. Ammoniacal nitrogen was particularly high. Exceedances were usually about 10 times the guideline value but on one occasion, the ammoniacal nitrogen concentration was 56 times greater than the guideline value. Such high levels of ammoniacal nitrogen are approaching concentrations that may be toxic to some species. Nitrate/nitrite typically exceeded the guideline value by about 2–3 times, but on one occasion the concentrations was 43 times greater than the guideline value. The cause of such high nutrient concentrations is not possible from this study. Common sources of excess nitrogen include raw and treated sewage, industrial discharges, and runoff or soil leachate from pastures, crops, and lawns that have been fertilised. There were no clear patterns between nitrogen exceedances and high tides or heavy rainfall as was seen at other sites during this sampling period.
Phosphorus (dissolved reactive) 	Phosphorus concentrations exceeded the guideline value on every sampling occasion. Excess phosphorus may lead to nuisance weed and algal growth. Common sources of excess phosphorus include runoff from pastures, crops, and lawns that have been fertilised.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

FAECAL BACTERIA

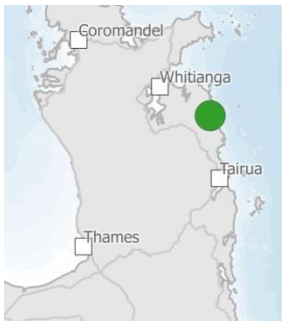
Enterococci 	Enterococci concentrations were within the guideline value on six out of eight sampling occasion. The two exceedances were up to six times greater than the guideline value and occurred following spring tides or heavy rainfall, which is common in these types of water. It is recommended to avoid swimming at these types of locations 24–48 hours following heavy rainfall.
Potential faecal sources detected	Ruminant animals (including cows), humans, possums, and gulls.

SUMMARY

During the two sampling months, nutrient concentrations at this location were elevated. The reason for the excess nutrients is unclear from this study and it does not appear to be directly linked to high tides or heavy rainfall, which was observed at other locations in this study. Faecal contaminants were usually within guideline values, except around high spring tides and following heavy rainfall, which is common for these water types.

Taiwawe Stream mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)



This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity levels were within guideline values on each sampling occasion. This indicates high water clarity at these times.
Dissolved oxygen 	Dissolved oxygen was always within the guideline value. This indicates that there was sufficient oxygen in the water at the time of sampling for the organisms that live there.
Nitrogen 	Nitrogen concentrations were within guideline values between fix to seven out of eight sampling occasions. Nitrogen concentrations were highest early January and decreased for the remainder of the sampling period. The reason for these elevated concentrations at this time are unclear from this study. Common sources of excess nitrogen include raw and treated sewage, industrial discharges, and runoff or soil leachate from pastures, crops, and lawns that have been fertilised.
Phosphorus (dissolved reactive) 	Phosphorus concentrations were within the guideline value on each of the sampling occasions. The levels of phosphorus on these occasions were unlikely to promote nuisance algal growth.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports

[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.

[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

FAECAL BACTERIA

Enterococci 	Enterococci concentrations were within the guideline value on six out of eight sampling occasions. The two exceedances were up to 1.3 times greater than the guideline value and occurred following heavy rainfall and during high spring tides, which is common for these types of water.
Potential faecal sources detected	Ruminant animals (including cows), humans, possums, and gulls.

SUMMARY

During the two sampling months, the ecological health was typically high. On occasion, nitrogen concentrations exceeded guideline values, but the cause of this is not apparent from this study. The relatively low concentrations of nitrogen and phosphorus were unlikely to promote nuisance algal growth at the time of sampling.

Faecal contaminants were usually within guideline values, except around high spring tides and following heavy rainfall, which is common for these water types. It is recommended to avoid swimming in these types of locations 24–48 hours after rainfall has occurred.

Grahams Creek mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)

This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity was within the guideline value on each sampling occasion. This indicates high water clarity at these times.
Dissolved oxygen 	Dissolved oxygen was within the guideline value on six out of seven sampling occasions. The one exceedance had an oxygen concentration >120%, which indicates oxygen production by organisms in the water. At the time of sampling, the water in Grahams Creek had sufficient dissolved oxygen for the aquatic species that may live there.
Nitrogen 	Total nitrogen concentrations were within the guideline value on all sampling occasions, however, nitrate/nitrite and ammonium exceeded their guideline values on four and three occasions, respectively. This indicates that the source of excess nitrogen is likely a result of the catchment land use and the resulting nutrients that are washed into the stream at the time of sampling. Common sources of excess nitrogen include raw and treated sewage, industrial discharges, and runoff or soil leachate from pastures, crops, and lawns that have been fertilised. Elevated levels of nitrogen may promote nuisance algae growth under certain conditions.
Phosphorus (dissolved reactive) 	Phosphorus concentrations were within the guideline value on each of the sampling occasions. The levels of phosphorus on these occasions are unlikely to promote nuisance algal growth.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

FAECAL BACTERIA

Enterococci 	Enterococci concentrations were within the guideline value on three out of eight sampling occasions. The exceedances ranged from about 1.5 to 3 times greater than the guideline value and indicate and elevated health risk when swimming in the water at the time of sampling. Three of the exceedances coincided with high tide and following heavy rainfall.
Potential faecal sources detected	Ruminant animals (including cows), humans, possums, gulls, and pigs.

SUMMARY

During the two sampling months, faecal bacteria and some nitrogen concentrations exceeded guideline values on occasion. These typically occurred during high tides or following heavy rain events, which is common for these types of water bodies. It is recommended to avoid swimming in these types of locations 24–48 hours after rainfall has occurred.

Pepe Stream mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)

This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity levels were within guideline values on each sampling occasion. This indicates high water clarity at these times.
Dissolved oxygen 	Dissolved oxygen was always within the guideline value at the time of sampling. This indicates that there was sufficient oxygen for the aquatic species that live there.
Nitrogen 	Total nitrogen concentrations were usually within the guideline value, whereas nitrate/nitrite and ammoniacal nitrogen concentrations frequently exceeded their guideline values. Ammoniacal nitrogen was particularly high, exceeding the guideline value by about 10 on six occasions. This may indicate that the source of nitrogen was from catchment land use, rather than 'natural' sources. Excess nitrogen may cause aquatic weeds and nuisance algae to grow.
Phosphorus (dissolved reactive) 	Phosphorus concentrations were within the guideline value on three out of eight sampling occasions. The exceedances were all less than twice the guideline value. Common sources of excess phosphorus include runoff from pastures, crops, and lawns that have been fertilised.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

FAECAL BACTERIA

Enterococci 	Enterococci levels were within the guideline value on five of eight sampling occasions. One exceedance that coincided with high spring tides was 20 times greater than the guideline value. The other exceedances were smaller with one being four times the guideline value following rainfall and the other being just over the guideline value. Water types such as this can be susceptible to elevated levels of faecal bacteria following heavy rainfall and high tides.
Potential faecal sources detected	Ruminant animals (excluding cows), possums, gulls, and pigs.

SUMMARY

During the two sampling months, nutrient concentrations (excluding total nitrogen) frequently exceeded guideline values. These exceedances did not seem to coincide with spring tides or rainfall events, unlike observations that had been made at other locations in the area.
Faecal bacteria was usually within the guideline value, but exceedances were measured following heavy rainfall and around high spring tides. It is recommended to avoid swimming at these locations 24–48 hours following heavy rainfall.

Otahu River mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)

This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page1.

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines3.

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity levels were within guideline values on each sampling occasion. This indicates high water clarity at these times.
Dissolved oxygen 	Dissolved oxygen was within the guideline value on each sampling occasion. This indicates that there was sufficient oxygen for the organisms that live there.
Nitrogen 	Total nitrogen concentrations were within the guideline value on all sampling occasions, however, nitrate/nitrite and ammonium exceeded their guideline values on four and six occasions, respectively. This indicates that the source of nitrogen is likely a result of the catchment land use and the resulting nutrients that are washed into the stream at the time of sampling. Potential sources include human and animal sewage and excess inorganic fertiliser that has been washed from the land or leached through the soil. Elevated levels of nitrogen may contribute to the growth of nuisance weeds or algae.
Phosphorus (dissolved reactive) 	Phosphorus concentrations exceeded the guideline value by up to about one and a half times on six out of eight sampling occasions. Common sources of excess phosphorus include runoff from pastures, crops, and lawns that have been fertilised. Elevated levels of phosphorus may promote nuisance algae growth under certain conditions.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

FAECAL BACTERIA

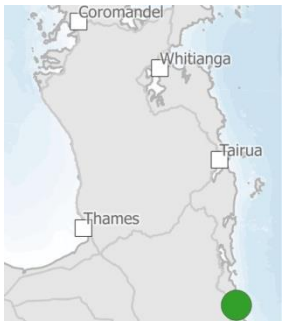
Enterococci 	Enterococci levels were below the guideline value on seven out of eight sampling occasions. The one exceedance occurred following heavy rainfall in the district, where contaminants are washed from the area surrounding the stream and flushed out to sea via the stream mouth. It is recommended to avoid swimming at these types of locations 24–48 hours following heavy rainfall.
Potential faecal sources detected	Humans, possums, and gulls.

SUMMARY

During the two sampling months, the ecological health of the site was suitable for the organisms that live there. Nutrient concentrations exceeded guideline values on occasion, which may be a result of the land use in the catchment. Faecal bacteria were typically below the guideline value, except on one occasion following a heavy rainfall event in the area.

Te Ramarama Stream mouth

Snapshot of coastal stream mouth water quality (Jan/Feb 2015)



This is a site-specific summary of the information obtained during a one-off snapshot of water quality in 18 Coromandel coastal stream mouths during January and February 2015. The snapshot was designed to investigate two aspects regarding water quality: 1) the ecological health of the system, and 2) the concentration and potential sources of faecal bacteria that, at high levels, can indicate a health risk. The full technical report, which includes all sites, can be found on the Waikato Regional Council technical reports page[1].

To put the measurements in context, they were compared to suitable guidelines. Measurements relating to ecological health were compared to the ANZECC2 guidelines and faecal bacteria measurements were compared to the New Zealand recreational water quality guidelines[3].

The exceedance of an ecological health guideline does not indicate that there are any adverse ecological effects. Instead, it may trigger further investigations to determine the cause of the exceedance and whether there are indeed any ecologically significant effects.

The exceedance of a faecal bacteria guideline may indicate an elevated health risk when swimming in the water. Public health implications in this part of the Waikato region are addressed in collaboration with Waikato District Health Board and Thames-Coromandel District Council.

ECOLOGICAL HEALTH

Turbidity 	Turbidity levels were within guideline values on each sampling occasion. This indicates high water clarity at these times.
Dissolved oxygen 	Dissolved oxygen was always within the guideline value. This indicates that there was sufficient oxygen in the water at the time of sampling for the organisms that live there.
Nitrogen 	The three different nitrogen measurements all differed to each other. Total nitrogen was usually within the guideline value, but exceedances were measured on two occasions, one of which was following heavy rainfall. Nitrate/nitrite and ammoniacal nitrogen were particularly high during one week with high spring tides. Likely, these nutrients are washed into the water from the nearby, low lying land. Elevated levels of nitrogen may promote nuisance algae growth under certain conditions. Common sources of excess nitrogen include raw and treated sewage, industrial discharges, and runoff or soil leachate from pastures, crops, and lawns that have been fertilised.
Phosphorus (dissolved reactive) 	Phosphorus concentrations were within the guideline value on six out of eight sampling occasions. The two exceedances were relatively minor and coincided with high spring tides, but not following heavy rainfall. Common sources of excess phosphorus include runoff from pastures, crops, and lawns that have been fertilised.

[1] Waikatoregion.govt.nz/Services/Publications/Technical-reports
[2] ANZECC & ARMCANZ. (2000). Australian and New Zealand guidelines for fresh and marine water quality. National Water Quality Management Strategy Paper No 4, Australian and New Zealand Environment and Conservation Council & Agriculture and Resource Management Council of Australia and New Zealand, Canberra, Australia.
[3] MfE & MoH. (2003). Microbiological water quality guidelines for marine and freshwater recreational area. Ministry for the Environment and Ministry of Health, New Zealand.

FAECAL BACTERIA

Enterococci 	Enterococci was within the guideline value on six out of eight sampling occasions. The two exceedances were up to 12 times greater than the guideline value and occurred following heavy rainfall and high spring tides, which is common at this type of location.
Potential faecal sources detected	Ruminant animals (including cows), humans, possums, and gulls.

SUMMARY

During the two sampling months, the ecological health of the site was likely suitable for the organisms that live there. Nutrient concentrations exceeded their guideline values in some samples, however, the cause of these exceedances is unclear from this study.Faecal bacteria were within the guideline value, except following heavy rainfall and high spring tides. It is recommended to avoid swimming at this locations during high spring tides or following heavy rainfall.